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THE

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KEELY AGAIN.

THE Rev. Arthur H. Plumb, D.D., a Boston divine, has published in the Boston *Transcript* of January 13th, a manifesto regarding the wonders he has witnessed during his late vacation at the Keely Laboratory, Philadelphia.

Unfortunately, Dr. Plumb is not an expert in mechanical science, as, to the credit of the cloth, many reverends have been, and are. The foremost fact he thinks miraculous is "a strong metallic wheel, weighing 72 lbs., in swift and steady revolution by the hour, and absolutely without cost." He seems to be unaware that, the only work necessarily expended in this exhibition, may be just the friction, which can be, by well known methods, reduced to but a very small matter. With beautiful inconsistency, he proclaims that his hero has "already so enlarged the domain of human knowledge, he has lifted man into such a new world of fact, the truths his experiments unveil are so novel, suggestive, and inspiring;" but when he has to speak about the new knowledge, or the new world of fact, he confesses himself completely obfuscated. He says: "On these declarations this witness has no testimony to offer." He is, therefore, after a prolonged sojourn with the "seer" of Philadelphia, no further forward in the new knowledge than those are who have never had this privilege.

Dr. Plumb is a Boston divine; we advise him to stick to his last, to lay it on his knee and read in it: "Every good gift and every perfect gift is from above, and cometh down from the Father of lights, with whom is no variableness, neither shadow of turning." All that revolving time has brought to light has been consistent with this statement. Slowly, indeed, the veil has sometimes been raised; but when the speed of revelation is accelerated, it never has been to show a break in the continuity which science reveals to us, a Divine unity, the worship of which is, in science and in ethics alike, the first commandment and the beginning of wisdom. The only source of power is in directed re-arrangements of matter. There may be new re-arrangements yet to be discovered, and these will always be hailed with gratitude by man. Power-giving re-arrangements are, however, only such as are, on the whole, accretive. Dispersion must be always at the expense of power. Keely, in professing to derive directable energy from the breaking-up of Nature's smallest parts, proclaims to every man who has a right to express an opinion on this subject that he, Keely, has never had a rational conception of what the order of Nature really is, and must always be, in regard to energy. If Dr. Plumb would try to understand this fundamental principle, he might explain it to his congregation when he is next addressing them on the physical side of the text quoted above. Another text he may preach from with advantage is the noble eulogium of invention, generally regarded by the orthodox as the proof of man's depravity. "They who are as the wise, who know the in-

terpretation of a thing, have sought out many inventions; a man's wisdom maketh his face to shine and changes the boorishness of his countenance." This is what Dr. Plumb may hammer out of the last on his knee. The man who is likely to be a successful inventor must have the preparation of the knowledge which enables him to interpret things. The man who first proclaims invention and immediately shuts himself up, trying for 20 years to discover the interpretation of the things before him is, according to Dr. Plumb's last, going stern foremost, even if he do have a parson on board. The names of eminent clergymen are commonly enough found as endorsers of quack nostrums, beauty soaps, electric belts, &c., but it is a novelty to find a prominent divine setting himself up as an expert on motors of the perpetual motion variety. Keely has evidently added to his Maskelyne and Cooke museum an electrical department, and electricians will not be surprised, however rapidly he may cause compass needles to spin, or how he may change their direction in azimuth. Only parsons and sailors' sweethearts now believe in the old adage, "true as the needle to the pole." He says: "That most constant of all things, the magnetic needle, you see charmed into fickleness by his magic spell." We do not object to the doctor's poetical language, but we would like to see more evidence of even a rudimentary knowledge of the science in which he comes forward as an expert. We have not attempted to follow Dr. Plumb in all the utterly valueless statements he has made. We are not surprised at his being carried away by what he saw, for we have often heard country people speak just in the same way after seeing Maskelyne and Cooke's performances.

TEMPERATURE COEFFICIENT OF COPPER.

Messrs. A. E. Kennelly and Reginald A. Fessenden have recently undertaken some experiments to re-determine the temperature variation in the electrical resistance of copper. The results were described by them in a paper read at the Chicago Congress, which is reported in the *Physical Review* for the past month. The object of these experiments was to try to account for the discordant results given respectively by Dr. Matthiessen and Dr. Siemens, and to obtain values which should be beyond dispute. It is curious that such discrepancy exists between the tests made by the two doctors; there is, however, no doubt that the curve giving the relation between resistance of copper, and temperature, by Matthiessen, is of a different order to that given by Siemens. Matthiessen, as the result of many tests on many wires, points to a temperature-coefficient augmenting with temperature, and negatives the supposition of a simple linear relationship between the variables. Dr. Siemens's researches formed the subject of a Bakerian lecture in 1871; they were undertaken with the object of getting a reliable scale for the electropyrometer, rather than for the direct purposes of scientific research. After pointing out that Matthiessen's formula can, on its own evidence, be only fairly applicable between the limits of 0° and 100° C., he advanced his empirical formula, supported by 170 observations, indicating a curve which bends downward, while the 250 observations of Matthiessen gave an upward curve. This apparent ambiguity becomes more pronounced when the results of the labours of Profs. Dewar and Fleming in this direction are taken into account. In an article in the *Phil. Mag.* for October, 1892, they give their observations on the conductivity of metals and alloys at temperatures between — 200° C. and + 100° C., one series for copper being included; their experimental values when plotted give very nearly a straight line law throughout the whole range, a result which agrees with the measurements made by some other experimenters: Arndtsen, Bouty, and Cailletet.

The wire tested by Messrs. Kennelly and Fessenden was sealed within the bulb of an air thermometer. Their final results—after full corrections for expansion of the bulb, &c.—are claimed also to indicate a linear relation between the resistance and temperature of the wire, between the limits of 20° C. and 250° C. They may be represented by the equation:

$$\rho_t = \rho_0 (1 + 0{\cdot}00406\, t),$$

pointing to a uniform temperature coefficient throughout the entire range of 0·406 per cent. per degree C., the maximum observed being 0·4097 per cent., and the minimum 0·399 per cent., at any point.

A general description of the apparatus is given in the paper. Within a cylindrical glass tube, forming part of an air thermometer, a length of about 240 cm. of fine copper wire was enclosed; short Pt. wires, sealed into the glass bulb, brought this copper wire into communication with apparatus for measuring resistance. The bulb was heated electrically in an oil bath; it was operated as an air thermometer at constant volume. The wire under test was threaded between mica-discs slipped axially over a central glass stem, perforations in the mica being provided for the wire to pass through. This commends itself as a very neat arrangement. The wire was about 20 ohms resistance at 20° C.; connection could be made with the middle point as well as the ends, so that it could be used in two sections, each of about 10 ohms, for check readings. The first trials were made with a Wheatstone's bridge, but this method of measurement was discarded, as not being sufficiently speedy, and was replaced by tests with the differential galvanometer. It is a little difficult to appreciate the need for this change; but it is not fair, perhaps, to complain when we have not all the conditions before us; slight temperature changes in the differential coils might cause errors of the same order as those resulting from the greater time required in using the bridge-method; and again, it would seem essential to accurate measurement that the wire should be kept at each observed point of temperature for a reasonable time, in order to be sure of uniformity, and certainly for the time required to take a bridge test. The mean cubical expansion of the glass forming the air-thermometer was assumed to be constant throughout the entire range (27·8° C. to 207·52° C.); this, perhaps, is rather a broad assumption.

Strangely enough, out of the six sets of tests, the first four series of observations, when computed and plotted, did show curves bending after the manner of Matthiessen's; but the descending curve was distinctly below the ascending branch, so that the diagram took the form of a loop; as

though the wire had a lower resistance, for a given temperature, when cooling, than when heating. This result is attributed by the authors to errors of observation, rather than to actual difference of resistance in the two conditions; they think that it may be accounted for, to some extent, by the fluid friction of the mercury in the thermometer tube. With each successive series of tests the curve straightened, and the two parts—heating and cooling—became more nearly coincident. The fifth and sixth series were regarded as satisfactory and reliable, they yielded almost straight lines, and were therefore accepted, to the exclusion of the preliminary four.

Unless some clearer explanation can be given for the curvature of the first four curves, the experiments can scarcely be said to have established anything very definite with regard to the validity of the straight-line law. Information is also wanting as to the certainty of the wire having taken up its temperature at each point; this is really the fundamental requirement of the test, and it would be interesting to know how much time was given in each case. It is very possible that copper, according to its physical condition and history, may have different ways of expressing itself when submitted to temperature changes, so that the curvatures may vary with the samples chosen; this, no doubt, accounts in part for the apparent ambiguity between the results of different experimenters; it will not, however, explain why tests upon one sample should give four curves and two straight lines. There is little doubt that the loop effect, between heating and cooling, was due, as attributed by the authors, to errors in the method of testing; for it is extremely improbable that the wire had different resistances under these two conditions, unless abnormal temperatures were reached. The chances are, therefore, that when the loop disappeared the tests were, for some reason, more accurate; and in this way the straight-line law may be justified. The upshot clearly is that, for practical purposes, the straight-line law may be accepted, for copper, without serious error. Elaborate tables of temperature co-efficients, drawn up upon the assumption of a logarithmic relation, are used when testing cables, in order to calculate the mean temperature of the tanks or sea-water, from the observed copper resistance. The temperature thus found is available for reducing the dielectric resistance to its 75° value. Experiment shows that calculations based on this method may be depended upon, and it is not likely to be discarded for any other just at present. But for ordinary purposes, and especially for small ranges of temperature, the straight-line law is evidently the one to use.

Is Chemical Change the Reverse of Electrolysis?

During the past few years two schools of thought have arisen, which, though widely opposed in matters of detail, agree in the general principle that chemical and electrical phenomena are more exclusively related to one another than to any other form of energy. On the one hand there are writers who hold that chemical change is the reverse of electrolysis; and, on the other, there are those who consider that chemical change is conditioned by the separation or dissociation of compounds into oppositely electrified ions. Both schools have set forth answers to the problems: what is chemical change, and what is the cause of its commencement? But even in these latter days of science there is a tendency amongst writers to accept the hypothesis of their predecessors as matters of acquired knowledge without due examination of their validity. Mr. V. H. Veley has recently called attention to this loose method of philosophy. In a paper in the *Philosophical Magazine* he reviews the phases and conditions of chemical change, and suggests that there is nothing to warrant the exclusive selection of two particular forms of energy, namely, the electric current and chemical affinity, and to define, absolutely, the latter as the reverse of the former. Probably the true position of the case is most exactly summed up by that frequently quoted deliverance of Helmholtz, viz., "The very mightiest among chemical forces are of electric origin." In the latter part of his paper Mr. Veley analyses the opinions of Arrhenius, Ostwald, Armstrong, Pickering, and others, and points out that the argument brought forward by Mr. Pickering seems, as yet, to have been unanswered and unanswerable, namely, that if we acknowledge the doctrine of electrolytic dissociation we must deny the principle of the conservation of energy, for which there is an abundance of direct evidence. The fact is we are all abroad, "So many men so many opinions." Writers on the subject seem to deal with chemical and electric forces, or with electrified and non-electrified atoms, as two cards in a game of "blind hookey," either of which may be turned up at will. As yet there seems to be no answer forthcoming to the question "Why does chemical change ever begin?"

The Differential Equation of Electrical Flow: Why Tesla was not Killed.

The theory of electrical discharge, as exemplified in the mathematical expressions employed to represent the physical facts, is apparently incompetent to explain all the phenomena observed in extreme cases; and the object of a paper read by Mr. T. H. Blakesley, before the Physical Society, is to show that the admission of certain properties of matter, not usually recognised, is the only way of obviating satisfactorily the imperfection of the existing views. In his investigations Mr. Blakesley does not employ exclusively algebraical symbolic methods, but, when it may be more advantageously adopted, he avails himself of the geometrical method. Such cases most frequently arise when magnitudes under consideration are capable of having negative values. As to nomenclature, the only scientific term employed admitting of doubtful interpretation is the effective electromotive force, by which the author intends to convey the idea of that E.M.F. which is numerically equal to the product of the current and the resistance at a point of time: this needs explaining, since a certain department of State has recently employed the term in a totally different state. A paper on the differential equation of electrical flow must needs be severely mathematical in tone; and one of the most important deductions established by Mr. Blakesley is that the ordinary theory has no provision for expenditure of power in the field, and hence does not explain the well-recognised phenomenon of radiation into space. Incidentally, he shows why no serious personal consequences followed upon some of Tesla's most startling experiments. The energy of the discharges which that physicist encountered was expended in chief part in radiation which his body did not check, and not in current through his body. In the discussion which followed the reading of this paper, Prof. O. J. Lodge, referring to Tesla's experiments, argued that no serious consequences followed because there was not much energy behind them; high frequency might be instrumental in preventing injury, but this he thought remained to be proved. As Mr. Swinburne pointed out, no great power was involved in these experiments, as the transformer could not give out any large power.

M. J. J. HEILMANN'S ELECTRIC LOCOMOTIVE.*

With the development of lines of railway, their traffic, and their penetration into countries with more and more irregular surfaces, the trains drawn by the locomotives have become heavier and heavier, the speed greater and greater, the gradients steeper and steeper, and the curves sharper and sharper.

To satisfy these ever-increasing requirements, the locomotive should possess qualities of stability, steadiness, adhesion, power and suppleness, which the ordinary locomotive, notwithstanding the incessant researches and improvements of which it is the object, possesses only in a very imperfect degree.

We cannot, in the space allotted to us, says M. Hospitalier in *La Nature*, examine in detail the respects in which the ordinary locomotive does not satisfy all these conditions; the innumerable types of locomotives at present employed by various railway companies in France and abroad have been chosen in each case with a view to meeting the special requirements of the service, and as being adapted to the peculiarities of the line, traffic, &c.

The oldest, most palpable, and most extensively used mode of applying electricity to locomotion, consists in producing the electrical energy in central stations and transmitting it to the vehicles by a conductor, which is more often overhead, but sometimes underground or level with the rail, the return of the current being effected through the ordinary rails.

The second mode consists in making a self-motive vehicle by producing the electrical energy directly by batteries, or by carrying a reserve in accumulators. This system seems to be limited to routes on which the journeys are short and the speed low. This application will be extended and made general as accumulators advance, and we shall have the electrical *fiacre*, but not the locomotive. At the most we should not get beyond the tramway; but it must be confessed that up to the present the attempts made in this direction have not been a success from a financial point of view, if they have from a technical one.

The third mode, of which the Heilmann locomotive constitutes the first conception and the first practical realisation, assigns to electricity a more subordinate *rôle*; it is employed merely for transmitting the mechanical power from the steam motor to the axles.

The energy undergoes a series of somewhat complex transformations from the time when it is generated by the combustion of the coal. After having been transmitted under a thermic form to the steam, it takes the mechanical form in a fixed engine, the electrical in a generating dynamo, and becomes mechanical again in the electric motors placed under the axles.

The object of these numerous transformations is to place the steam motor under better conditions of working than the ordinary locomotive, to render the entire weight available for steadying purposes, to enable the dimensions and consequently the power of the locomotive to be increased; and, lastly, to impart to it, by employing bogies, a suppleness far above that of ordinary locomotives. The combination presents other accessory advantages, due to the fact that all the apparatus requiring care and maintenance are under the front cover, and can be easily attended to; the stoker and the driver are separated, and their duties are quite distinct; the latter, whose place is in front, is better able to watch the road and the signals, and manipulate the apparatus in his charge at the right moment. Lastly, owing to the smoothness of the motion, which is free from rocking, jerking, and other drawbacks peculiar to the locomotive, there is less wear and tear of the road, and thus a considerable saving is realised.

We will now describe the locomotive in its latest form, which embodies all the various transformations it has undergone since its first conception, and in which form it is now in use on the Western Railway.

The locomotive is 16 metres in length between its buffers, and is mounted on two steel frames and supported by two bogies with four axles each, the eight axles being set in motion by an equal number of electric motors fixed upon them.

Each bogie is formed of two steel frames with a number of accessories, which we have not space to describe in detail, and which ensure the weight being equally distributed over all the axles, and which also impart a rotatory movement and the slight displacement throughout which is necessary for rounding curves. The bogie with four axles allows of the progressive passage of the weight at the rail joints, reducing in a great measure the height of the fall of the vehicle at these points.

The weight of the locomotive when in working order amounts to 110 tons, which is rather high in comparison with the power available at the axles, and higher than that in ordinary locomotives working by direct action; but we must not lose sight of the fact that we are discussing an apparatus that is as yet in its experimental stage; the system will be simplified and made considerably lighter in subsequent models.

The steam is furnished by a tubular boiler of steel, of the

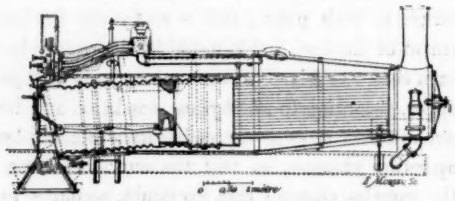


Fig. 1.—Boiler (Lentz Type).

Lentz type (fig. 1), 7·9 metres in length and nearly 2 metres in diameter, with a total heating surface of 145 square metres. The steam is produced at a normal pressure of 12 kilogrammes per square centimetre.

The furnace, which is of corrugated iron, has a prolongation forming a combustion chamber in which the cinders are deposited, and from which they are periodically extracted by a jet of steam. The hot gases are drawn into the chimney by the escape of steam, which thus produces a draught proportional at each moment to the speed of the engine.

A coal box for six tons, and reservoir of water holding from 10 to 12 tons, are placed on each side of the boiler, thus converting the whole into a locomotive and tender in one. The chimney is behind, and the door of the furnace opens towards the front. This combination favours the draught and facilitates the duties of the stoker, whose place is on the platform between the boiler and the steam motor, and who is separated from the driver, whose place, as we have said, is right in front.

The steam engine, which is actuated by the steam from this boiler, has two cylinders, high and low pressure, working two cranks placed at 180°.

By this ingenious combination, which was specially designed by Mr. Ch. Brown, the two pistons, although unequal in diameter, have the same mass and the same course, and always move in opposite directions with the same speed, which exactly balances their movements, and destroys the disturbing oscillations of their alternations. This motor (fig. 2) works under economical conditions, entailing the

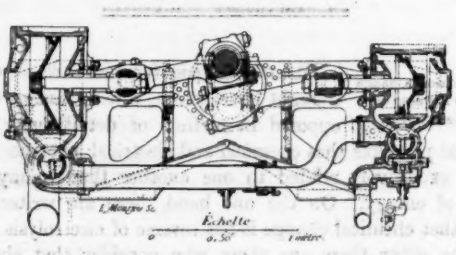


Fig. 2.—Steam Motor (Charles Brown System).

minimum consumption of steam for a given prolongation of its axle towards the point of the locomotive. The continuous current dynamo has six poles, with a ring armature, field magnet of soft steel, and proportioned pole pieces. The winding enables it to work with three, two, or even one pair

* We commented upon this apparatus in our leading columns last week.—Eds. Elec. Rev.

of brushes; these brushes are of carbon, like those of the electro-motors. The framework forms a crown, the external diameter of which is 2 metres; the diameter of the armature is 1·24 metres. This dynamo produces normally 1,000 ampères at 400 volts, or 400 kilowatts. It is excited separately by an independent compound dynamo, with four poles worked by a special vertical engine, with two cylinders and pistons with balanced movements like the principal engine. From this dynamo is obtained normally an output of 50 volts and 260 ampères. One part of the current is used for the excitation, the other for lighting the train and charging power, the speed being variable. At an angular speed of 360 turns a minute, it produces an available power of 600 H.P., increasing to 800 H.P. when the speed is 800 turns a minute. The steam, when it has arrived at an initial pressure of 12 kilogrammes per square centimetre in the small cylinder during $\frac{60}{100}$ of its course, expands there, and arrives at the large cylinder under a pressure of 4·5 to 5 kilogrammes per square centimetre, whence it is equally distributed through $\frac{60}{100}$ of its course.

The steam engine directly works the continuous current dynamo (fig. 3), and accumulators are placed in the luggage

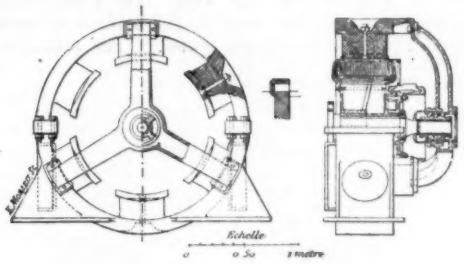


Fig. 3.—Dynamo (C. E. L. Brown).

van for the purpose of ensuring and continuing the lighting during the stoppages of the exciter.

This exciter also enables the dead point of the large steam engine to be passed when it has finally stopped there. This result is obtained by connecting the armature of the large dynamo to the exciter for a moment; the large dynamo then works as a motor, and thus draws the steam engine past the dead point.

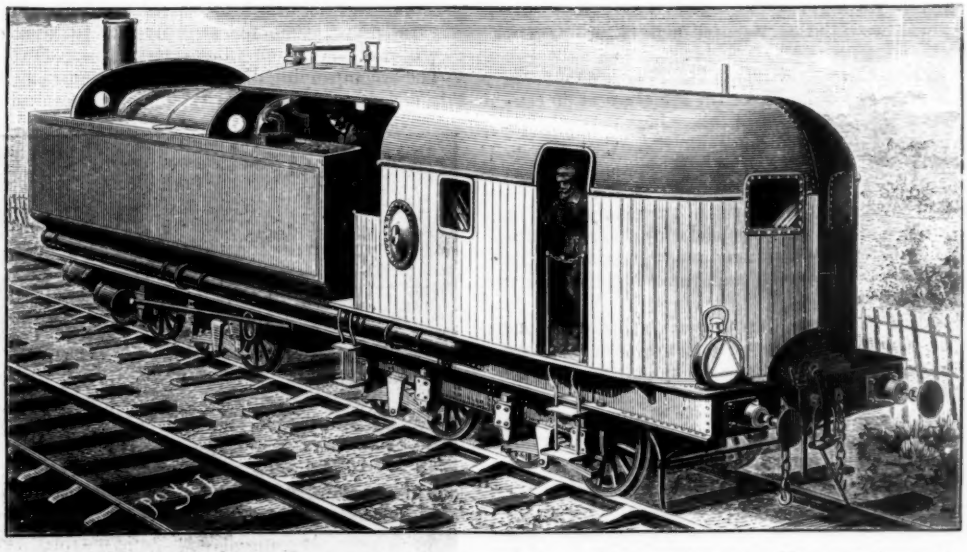


Fig. 5.—View of the Heilmann Electric Locomotive, from a position near the front. (From a photograph.)

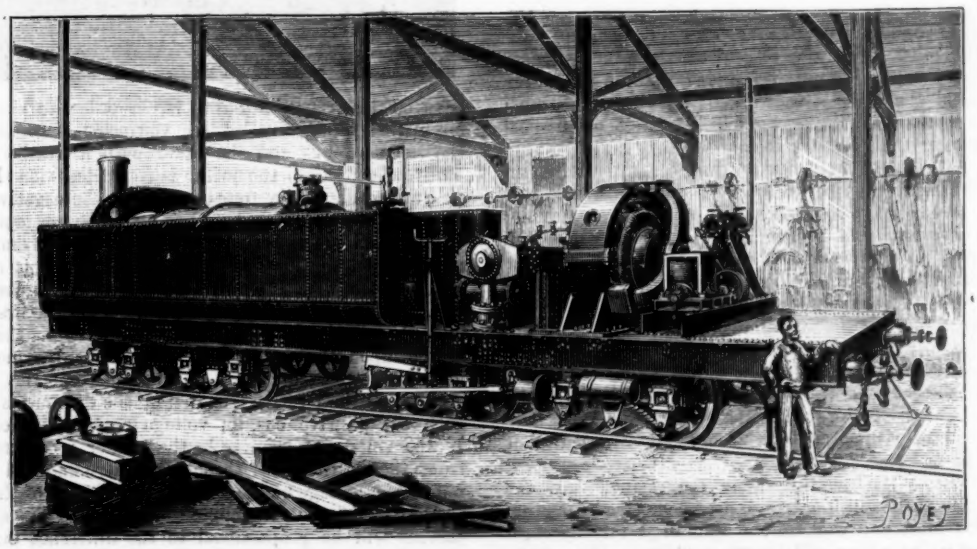


Fig. 6.—Side View of the Electric Locomotive with the front cover removed to show the steam engine, the generating dynamo, the exciter and its special engine. (From a photograph.)

The weight of this engine does not exceed 5,100 kilogrammes, which corresponds to a relatively high specific power, the engine not weighing more than 10 kilogrammes per effective H.P. The consumption of steam is 11 kilogrammes per effective H.P.

The electric motors, eight in number (fig. 4), are of the type with four poles and inductive coils, so that they occupy the least space possible under the body of the locomotive.

The field magnet is of cast steel. The frame is cast in one single piece, and the cores of the bobbins are made to correspond. These cores are round. The armature is a

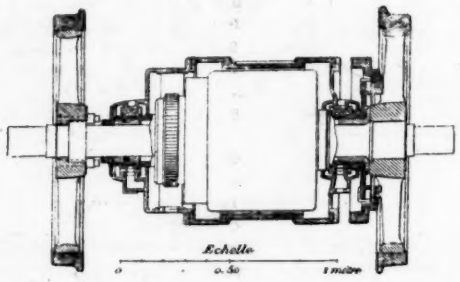


Fig. 4.—Electric Motor Mounted on each Axle.

toothed ring, but the teeth are employed mainly for drawing the wire along mechanically. The air gap has been left rather large with a view to reducing the Foucault currents in the pole pieces. The diameter of the armature is 65 centimetres. It is mounted on a steel tube which supports the whole machine, and which is fitted on the axle with the interposition of *woodite*, an elastic insulating material that is impervious to oil. The steel tube terminates at one of its extremities in an elastic coupling, which prevents jerking at starting. Special arrangements are made for ensuring automatic lubrication, for the inspection and regulation of the carbon brushes, for unmounting and removing the motor mounted on each axle, &c.

The eight motors form two groups, each comprising four motors coupled in parallel. For starting, the two groups are connected in series, and then coupled in quantity when the train has attained a certain speed.

An interrupter enables each motor individually to be withdrawn from the circuit, either when it has become damaged or when it is expedient to reduce the power supplied by the dynamo without changing its excitation or its speed. The reversing of the engine is effected by reversing the current in the armature by means of a special commutator. The fore part of the locomotive, which is shown in figs. 5 and 6, and on which the driver takes his stand, contains all the controlling, measuring, regulating, and manipulating apparatus required for the complete study of the working of the locomotive in the different trials to which it is being subjected. We must await the results of these experiments before we can express any well founded opinion as to the advantages of the locomotive worked by electrical transmission over the locomotive worked by direct mechanical transmission, or the ordinary locomotive.

As we have stated in a former number, the Heilmann locomotive has travelled between Havre and Beuzeville, over gradients of 8 in 1,000, at a speed of 55 kilometres per hour, and over gradients of 3 in 1,000 at a speed which has attained to 80 kilometres an hour over a straight part of the line, or round curves with a radius of 1,200 to 2,000 metres, drawing a load of about 90 tons, and performing for several days the work of an ordinary train. If these first results are not sufficient to warrant our jumping to a conclusion, they are at least encouraging; they have shown clearly the special qualities of the electrical transmission of the movement to the bogie frames, and have proved to the most sceptical that they were not dealing with a vain conception, and a system that could not be realised.

"The proof of the pudding is in the eating," says the proverb. M. Heilmann has proved his locomotive by making it run. We must now wait for the opinion of railway engineers. Let us hope they will find the *pudding* to their taste. This is what we wish M. Heilmann most sincerely.

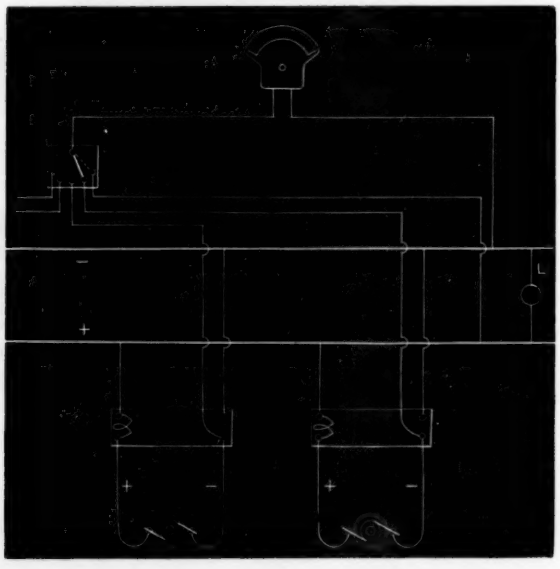
Sheffield Town Hall and Electric Lighting. — Provision is to be made in the new Town Hall for the supply of electricity throughout.

SWITCHING DYNAMOS IN PARALLEL.

In order to ascertain with one voltmeter when the voltage of a dynamo is at the right point for switching it into a line in parallel with others, the instrument is connected alternately with the line and the dynamo by a switch. Besides other disadvantages inherent to this method, the voltage of the line may change while that of the dynamo is being measured, and in electric railway stations where the pressure on the line is continually fluctuating, this objection is a serious one. Mr. W. H. Brenner, of Montreal, Canada, has devised a simple and reliable method whereby this difficulty is overcome, and the proper moment for switching in a dynamo can be ascertained with one voltmeter without danger of error. His method has been in use for some time in the temporary power station of the Montreal Street Railway Company, where it has given great satisfaction owing to its convenience and accuracy, and has been adopted for the new station of the company.

By this method the dynamo is connected temporarily with the line in series with the voltmeter, in such a manner that its voltage opposes that of the line. The voltmeter will then indicate the difference between the two voltages, and in this way the proper time for switching in the dynamo may be ascertained.

The accompanying diagram shows the manner of applying this system to a station with four dynamos. A lamp, L, is



inserted between the bus bars, in order to complete the circuit. One terminal of the voltmeter is connected with the negative bus and the other with a five-point switch. The first contact of the switch is connected with the positive bus, and each of the four others with the negative terminal of one of the dynamos, only two of which are represented in the diagram. The positive terminal of each dynamo is connected with the positive bus by bridging this side of its main switch with fuse wire. To read the voltage of the line, the five-point switch is placed upon the first contact; but, when it is desired to throw in a dynamo, the switch is moved upon the proper contact, and the dynamo and voltmeter are thus connected to the line in series with each other. As the positive terminal of the dynamo is connected with the positive bus, its voltage opposes that of the line. If the voltage of the line be the greater, a current will flow from the positive bus through the dynamo and voltmeter, but, if the voltage of the dynamo exceed that of the line, the current will flow in the opposite direction. The quantity of current will be proportional to the difference between the two voltages, and the voltmeter will indicate the difference in the pressure of the line and dynamo. When the two voltages are equal no current will flow through the circuit and the voltmeter will indicate zero. Thus the proper time for switching in the dynamo is indicated. If the dynamo be connected with the line by the five-point switch before starting, the high resistance of the voltmeter will prevent an appreciable current from flowing through the circuit.

THE TRANSFORMATION OF ELECTRIC CURRENTS.

Prof. Silvanus P. Thompson delivered a discourse on Friday evening last at the Royal Institution, on the important subject of the transformation of electric currents. The numerous instructive and amusing experiments were made to illustrate the conversions made use of in practice, and the intricacies of parallel and series connections, and the differences between continuous, alternate, and re-dressed currents were rendered clear to the mixed audience by lantern diagrams and ingenious mechanical analogues. In fact the lecture was most carefully thought out, and its effect enhanced by a series of splendid experiments.

Starting with the well-known continuous current, the lecturer advanced by successive stages to alternate currents, and culminated by showing polyphase current phenomena. Such terms as lag and phase were happily omitted from beginning to end, and their place well supplied for the time by simple expressions which appealed to the least technical part of the audience.

Prof. Thompson has evidently strong faith in the future of polyphase working for power work, and having a Drehstrom generator and motor at his disposal, was able to show some amusing as well as instructive experiments. The most striking to the ladies was that illustrated in fig. 1. An

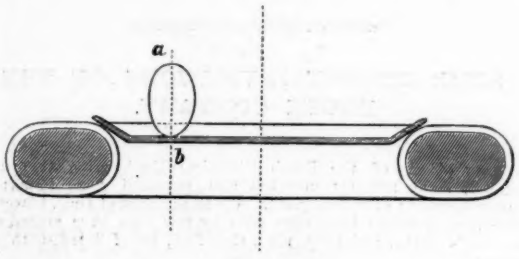


Fig. 1.

ordinary porcelain plate was laid in the centre of a Gramme ring, with the commutator and shaft removed, and a large hollow copper egg was placed in it. The windings of the armature were coupled at suitable places to the three leads from the Drehstrom generator, and hence being supplied with a three-phase current, a rotary magnetic field was set up, and caused the egg to, first, revolve slowly, then more quickly, and, finally, to rise on to its major axis, *a*, *b*, and spin at a high rate of speed.

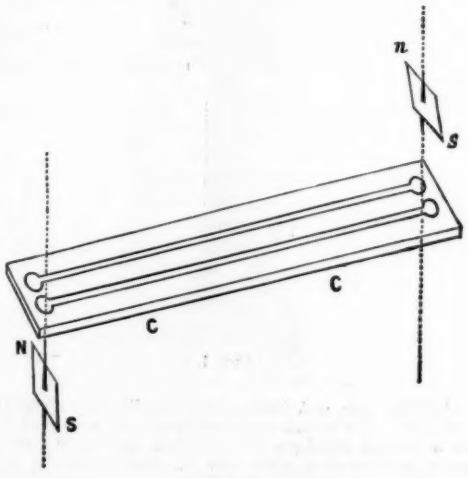


Fig. 3.

The same experiment was repeated with a flat disc of copper. This first became violently agitated, and finally leaped on to its edge and spun round.

These were striking exhibitions of the rotary magnetic field, but could have been readily foreseen. That shown in fig. 2., however, is new, and suggests in a remarkable manner the slow progress of science. N, S, is a permanent magnet capable of being rotated about an axis, so as to produce a rotary magnetic field. C, C, is a flat strip of copper with two slots cut in the direction of its length which terminate in two holes at each end. The copper, as a whole, thus represents the conductors of a polyphase circuit.

When one end of the strip was placed over the rotary magnetic field polyphase currents were set up in the copper, as was evidenced by placing a small pocket compass, *n*, *s*, above or below the other end of the strip, for its needle then immediately began to revolve. Outside the radius of the rotary field the compass needle simply vibrated, but within the circle it at once revolved. This result could have been foretold by simpler experiments from Arago's copper disc discovered some 100 years ago. And if, as Prof. Thompson pointed out, the transmission of power by rotary magnetic fields had then been discovered, we should not have talked about electric currents or electric circuits, but our ideas would instinctively have dwelt in the medium around the copper. It is interesting now to look backwards along the line of discovery, through the various classical experiments of the last century, to note their important issues leading up to the development of the laws of electricity and magnetism, and to think that it was possible to have arrived at our present state of knowledge in an altogether different way. Yet such seems to be the case.

M. Pollak was present during the lecture and showed his new alternate current re-dressing commutator. This was coupled to the London Electric Supply Corporation's mains, and was connected to the accumulators of the Royal Institution during part of the evening. It was not possible to judge the action of the "re-dresser" as exhibited, and, therefore, we will reserve our opinion for the present, merely stating now that a continuous current of about 45 ampères and 85 volts was obtained, but with more sparking than is permissible in practice. It is fair to state that the "re-dresser" was designed for a frequency of 50 ~, and, therefore, was at a disadvantage on a circuit of 133 ~.

Mr. Ferranti's re-dresser was also shown in the library, but it was not working.

REVIEWS.

Local Government Manual, 1894. London: H. Edgecumbe-Rogers, *Local Government Journal* office.

This is a useful book of classified information relating to the members, officials, and duties of the local governing bodies throughout the country. The book would be found useful in the office of electrical engineers, contractors and others, who seek to do business with public authorities.

Laxton's Builders' Price Book for 1894. London: Kelly and Company.

For over seventy years this has been the reference book on all matters relating to the value of every description of work or material involved in building operations. The section devoted to electric lighting, which increases year by year, and is brought well up to date, now occupies nearly 30 pages. This edition contains the whole of the Metropolitan Buildings Acts, Metropolis Management Acts, Public Health Acts, with cases and decisions in the courts; bye-laws, rules and forms of the London County Council, and lists of the aldermen and members of the council, and of the district surveyors, with their respective districts; and many other special additions to the ordinary contents of the book.

Lockwood's Builders' and Contractors' Price Book for 1894. London: Crosby Lockwood & Co.

This annual publication is a comprehensive handbook of the latest prices of every kind of material and labour in trades connected with building, and contains, also, the sanitary bye-laws of the County Council; the principal provisions of Acts of Parliament relating to building and sanitary matters; legal notes and memoranda; the rules and regulations of the London County Council and other public

bodies; and a variety of information on a number of matters of interest to the building trades. The electric lighting information is well put together, and concludes with a copy of the general conditions of supply issued by the City of London Electric Lighting Company.

Modern Shafting and Gearing. M. Powis Bale, A.M.I.C.E. William Rider & Sons, Limited, London.

This is a little hand-book which, as far as it goes, is excellent. It describes the modern improvements in shafting, bearings, pulleys, and belt fasteners, also of friction couplings, and self-aligning and adjustable bearings are well dealt with; it is a useful little work, inasmuch as it touches upon data regarding things which are too new to be found in the standard works on engineering. It contains only about 100 pages, so that the subjects are very briefly treated.

A Pocket-Book of Electrical Engineering Formulæ. By Giepel & Kilgour. London: Electrician Printing and Publishing Company.

The reference work professes to deal particularly with the heavier branches of mechanical and electrical engineering, It is well and skilfully compiled, the matter is selected with evident care, but much of it is only condensed text-book information. The mechanical engineering parts of the work are more extended and enter into much greater detail than the electrical, which altogether form a very small moiety of the work; in fact, useful formulæ for electrical problems are conspicuous by their absence. The alternate current transformer is very inadequately treated, in as far as formulæ are concerned, and so is the alternating current dynamo; the electrical formulæ requires a good deal of simplification to fit it for an electrical hand-book for general use among engineers. The work seems to be addressed more to students having a mathematical education, than to engineers, draughtsmen, and practical electricians, and many subjects of great practical importance in heavy electrical engineering are very briefly alluded to or altogether omitted. On the other hand there is a good deal of up-to-date information given in regard to the subjects which have been treated fully by the authors. Much of the text-book style of matter might very well be replaced by useful practicable formulæ.

Journal of the Institution of Electrical Engineers. No. 108. London: E. & F. N. Spon, 125, Strand.

This number is chiefly devoted to the paper on "The Electrical Transmission of Power from Niagara Falls," by Professor G. Forbes, F.R.S., with the discussion on the same.

Electric Waves: being Researches on the Propagation of Electric Action with Finite Velocity through Space. By Dr. Heinrich Hertz. Authorised English translation, by D. E. Jones, B.Sc. London: Macmillan & Co.

The very remarkable series of researches undertaken by Dr. Hertz have created great, rather than widespread, interest, for it is but comparatively few who are able to follow the abstruse reasoning involved in the subject. So important, however, are the researches that Lord Kelvin, in a preface which he has written for the book, states that "the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a permanent monument of the splendid consummation now realised." The series of papers containing the researches were originally published in *Wiedemann's Annalen*, and translations have appeared in English periodicals; the series have been reprinted and supplemented by explanatory notes, together with an introduction describing the manner in which the investigations were undertaken, and also discussing their bearing upon electrical theory and the criticisms to which they have been subjected.

Thoughts on Faith and Scepticism. By Thomas Andrews, F.R.S. London: J. Nisbet & Co., 21, Berners Street.

This work is divided into four parts and an appendix, viz.: Part I. Remarks on christian faith; II. Observations on hyper-biblical criticism; III. Passing thoughts on modern scepticism; IV. Remarks on spiritualism and theosophy; Appendix—passing thoughts on atheistic teaching in French schools; progress of Romanism and ritualism in England; religious teaching in education; present attitude of the Church of Rome towards protestants. It would hardly be suitable for us to examine this book in a critical spirit; there is much which is very interesting and which we admire in it, much with which we agree and also some portions with which we disagree. It is unfortunate, we think, that certain men who pride themselves upon being learned in science, and, therefore, one would imagine, would be close and fair reasoners, are often so imbued with the *odium theologicum*, that they (perhaps unconsciously) show a very marked bias towards one particular school of theological thought, and consequently deal most unfairly with another school simply because they really are ignorant of the true facts of the case and cannot believe that anyone who does not share their own narrow views can possibly be right. There are two sides to every question, and it is hardly fair to select the utterances of certain bigots to prove a case and leave out the utterances of others who can put a very different complexion on the matter, and who certainly have a right to be heard, even though we may not altogether feel sympathy with them.

SOME RECENT INVENTIONS OF THE BRUSH COMPANY.

Certain officers of the Brush Electrical Engineering Company, Limited, have recently invented and patented some important improvements in electrical plant. Up to the present time, however, these improvements have been seen by few who have visited the company's works, and they may, therefore, be of interest to our readers.

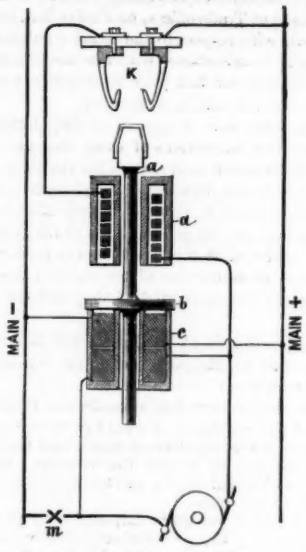
The inventions are of a most important character, inasmuch as they have for their object the simplification of central station working and the reduction of risk of accidental stoppages, which sometimes occur through carelessness or nervousness on the part of the attendants, or from disablement of some part of the plant. We describe below a few of the devices to which we refer.

Raworth's patent automatic switching gear is applicable in all cases where two or more continuous current dynamos or exciters are arranged to work in parallel on a common circuit. The apparatus, as shown in fig. 1, consists of a cast-iron pillar which carries

Fig. 1.

the switching gear and instruments, usually one ammeter and one voltmeter. The switch closes automatically when the dynamo attains a voltage equal to that existing in the station mains. It opens automatically when the dynamo ceases to generate current. To bring another dynamo into circuit the weighted lever has to be fixed up to the engine. To take a dynamo out of circuit steam has to be shut off. Referring to the diagram fig. 1a, it will be seen that the main switch is carried on a vertical rod, *a*, on which is an iron armature, *b*. This armature moves between two magnets, *c* and *d*, of which the lower one, *c*, is magnetised by a shunt from the mains, and demagnetised by a shunt from the dynamo terminals. The upper magnet, *d*, is magnetised by the main current passing from the dynamo to the station mains. When the dynamo is at rest the lower

magnet binds the armature down and locks the switch out of action. When the dynamo gives its full voltage the magnet, *c*, is demagnetised and the switch is closed by the weighted lever. The switch is held in position by the magnet, *d*. On turning off steam the magnet,



The switch, K, is double-pole and includes the switch *m*.

Fig. 1A.

d, releases the switch, which falls by gravity and opens the circuit. The weighted lever has, on starting the engine, to be put in gear with the switch by means of a small catch or pawl, which automatically releases when the switch closes. It is intended that the switch pillar shall be placed near the dynamo so that the instruments may be in the view of the attendant in turning on steam. It is claimed that this automatic switching gear entirely prevents accidents from: (*a*) Closing switch when dynamo is unexcited or not giving full E.M.F.; (*b*) Closing switch when polarity of dynamo is reversed; (*c*) Current coming back on dynamo and burning down the fuses.

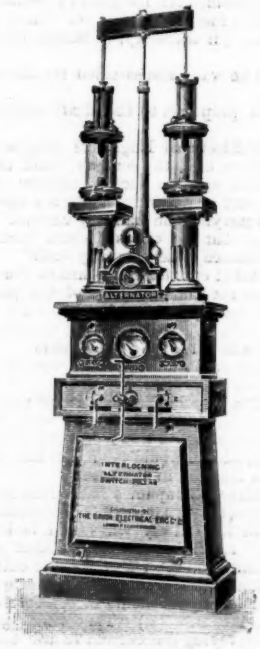


Fig. 2.

Raworth's patent interlocked switching gear is said to greatly facilitate the working of alternators in parallel; its general appearance is shown in fig. 2. The main switch lever is in the middle, the field switch on the left, and the synchroniser switch on the right. The interlocking gear is arranged so that the main switch cannot be closed until the field switch is closed and the field fully excited, also not until the synchroniser switch is closed. When the main switches are closed, the field switch cannot be opened, and the main switches are locked by shutting off the synchroniser switch.

The main switches break through water and oil, and are practically sparkless under all conditions.

It is claimed that this gear entirely prevents accidents from:—(*a*) Closing main switch when alternator is unexcited or not giving full E.M.F. (*b*) Opening field switch when main switch is closed.

Raworth's patent interlocked switching gear for main feeders, continuous or alternating currents, takes the form of a cast-iron pillar which carries the main switches, fuses, ammeter and voltmeter, regulating gear, and interlocking machinery. The general appearance is shown in fig. 3. In the base of the pillar, where the leads enter,

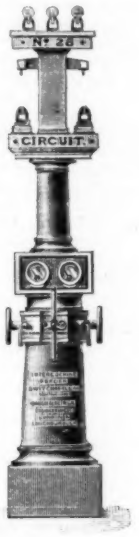


Fig. 3.

there is a switch for disconnecting the upper part of the pillar and for establishing the circuit, in order that the instruments, fuses, and switches may be examined and repaired without cutting off the feeder. There are three fuses fixed on the top of the pillar, any one of which may be put in circuit by turning the right hand handle, but this handle cannot be moved unless the main switch be open. Double-pole switches are fixed below the fuses, and are actuated by the central handle, which is locked by a trigger, which must be released before the switch can be opened or closed. The handle on the left actuates the disconnecting switch, but it cannot be moved unless the main switch be open. The regulation is effected by two hand wheels fixed on a shaft which passes through the pillar. The regulating apparatus varies with the system of generation employed. For continuous current it consists of a variable resistance or a set of back E.M.F. cells. In the event of a fuse failing, a new one can be put in circuit in 3 seconds. Should all three fuses fail a new set can be inserted by hand in 10 seconds. By means of the disconnecting switch any part of the gear can be examined and repaired without any possibility of shock. The handles are all interlocked, and this prevents mistakes.

Raworth's patent return current fuse, for use with alternators in parallel, is asserted to render the parallel working of alternators per-

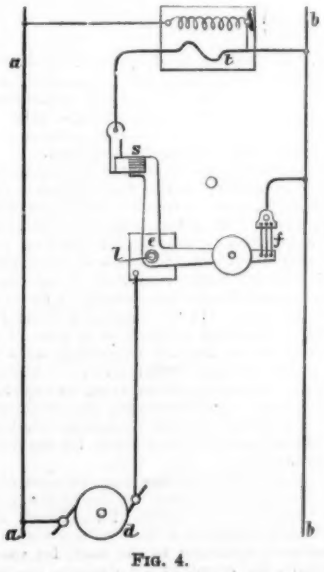


Fig. 4.

fectly safe, because the fuse will melt only with return current; that is to say, the fuse cannot be melted whilst energy is being transmitted from the alternator to the mains, but should the alternator from any

cause fail to give its full E.M.F., the fuse will immediately act and cut it out of circuit. With plain fuses the possibility of a total extinction is always present; for instance, if three alternators be working in parallel and one of them fail, then the other two have to supply current for the outer circuit and sufficient additional current to burn down the fuses of the disabled alternator. Under these conditions all the fuses would go simultaneously or the fuses of the two working alternators might melt without cutting off the disabled alternator. With the new return current fuse the inventor claims that this cannot happen, as it will not act with excess current in the right direction, but only with current in the wrong direction. The principle of the return current fuse is as follows :—Two paths are provided, one through the fuse and the other through an accelerator, which gives the current a bias to select the latter path, but the accelerator has a contrary effect on a return current, forcing it through the fuse. Referring to fig. 4, *a* and *b* are the omnibus bars, *d* the alternator, *e* a weighted lever, *f* the fuse. The accelerator, which is a small transformer, is shown at *t*. It will be seen that the current enters at the joint, *l*, from which point there are two paths open to it to the omnibus bar, *b*—one through the switch, *s*, and the accelerator, *t*, and the other through the fuse, *f*. The accelerator has the effect of slightly increasing the E.M.F. by something under half a volt, which is sufficient to induce the current to select that path in preference to the path by the fuse, but in the event of the current returning upon the alternator, the accelerator acts as a retarder and forces the current through the fuse, which as it melts liberates the switch, *s*, and cuts off the alternator.

An advantage claimed for Raworth's patent universal electrical contact shown in fig. 5, is that it presents large surfaces of contact which remain parallel or at the same angle to each other under varying degrees of pressure. The contact piece is a casting and is made for use with bar or plug connectors, either parallel or taper. For taper connectors the contact surfaces are arranged at such an angle that the bar or plug will stick between the contact faces, but may be removed by the exertion of a

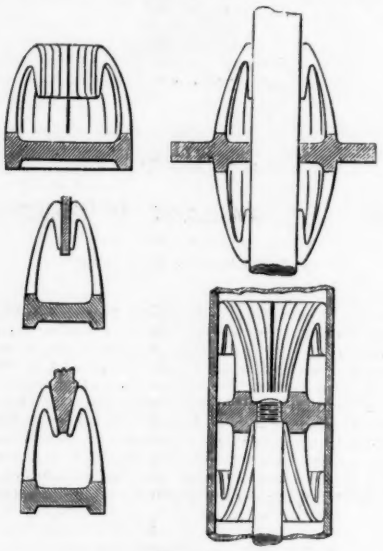


Fig. 5

very slight force. The surface of contact is fully four times the sectional area of the metal. Sparking contacts are provided for preventing deterioration of the faces. The contact pieces are standardised for 250, 500, and 1,000 ampères, each having a large margin. The internal sliding contact and the external revolving contact it is thought will be found very useful in special cases.

Mordey's patent automatic transformer switch has been designed with the view to avoid loss of power during the daytime or periods of light load by automatically removing transformers from circuit when not required for use. It is of simple and safe construction, and has been developed with a special view to being left for long periods without attention, and has been subjected to long and severe tests.

The Brush-Geipel automatic regulator of the water type is a development of the well-known combination of the Brush automatic regulator and Geipel relay. In this improved form of the regulator, the variable shunt resistance consists of a pair of carbon plates immersed in water to an amount depending upon the resistance required. The plates are hung from a lever, the movement of which is controlled by an electro-magnet receiving its impulses through the relay. The movements of the lever vary the extent of immersion of the plates and produce the required regulating effect in the fields of the dynamo. The apparatus is now made for use with all standard sizes of Brush dynamos.

Mordey's patent automatic rocker gear consists of an automatic rocker, intended to take the place of the ordinary hand adjusted rocker, used for carrying the brushes of the Brush dynamos. It is controlled by an electro-magnet in the regulator circuit, and is moved forward or backward according to the load, for example:—If the number of lamps on the circuit of the dynamo be altered, or if the speed of driving it be varied from any cause (the current being maintained constant by the Brush-Geipel regulator) by this new device, the brushes are brought into the position of best collection. This movement has hitherto been done by hand.

ELECTRICAL TRACTION.

Sir Courtenay Boyle, C.B., again presided at the adjourned conference of the representatives of various bodies interested in electric traction at the Board of Trade offices, on Friday last, to consider objections and proposals with respect to the draft regulations prepared by the Board of Trade, in accordance with the recommendations of the joint committee which sat last year to consider the conditions on which electric traction should be authorised.

Several amendments were proposed on Regulation No. 9, which dealt with construction in sections of every line and every insulated return, and the isolation of each section for the purposes of testing.

Mr. Dickinson said that, from experiments made in South Staffordshire with poles connected, he contended that Regulation 5, limiting the current going through the general mass of the earth, could not be carried out. He believed if the whole of the poles were connected they would still get three-fourths of the current through the earth. He said no line could be constructed if they insisted upon the regulation applying.

Mr. Langdon (on behalf of the Associated Railway Companies) said that if there was a sufficient return to the generating station the current would return there.

Mr. Dickinson said if they had a conductor three times as large, and the earth had less resistance, it would go to the earth.

Mr. Langdon said the regulations stated that the conductor must be of sufficient section to return the current. They had been seriously affected at Walsall by the electricity going into the ground and interfering with the wires.

Mr. A. Siemens said it was quite impossible to prevent electricity going into the earth. If there were ninety-nine ways of returning it would follow them all. With regard to Mr. Langdon's remarks about the instruments being interfered with, might he point out that it took three manipulations before a block signal was acted upon? However much a tramway might be isolated, the instruments of a railway company were always susceptible to the ordinary meteorological currents, which presented just as much difficulty.

Mr. Langdon explained the working of the block system on the Midland Railway, and said the great difference between the tramway and the meteorological effects were, that the latter only came occasionally, whilst the former would be with them continually.

After further discussion, the Chairman said it was perfectly impossible for him, acting for the Board of Trade, to decide a question which was absolutely a scientific one. He must act upon the advice of the electrical expert attached to the board of Trade, and the best thing was for Major Cardew to go down into Staffordshire and see the experiments and see how far these justified Mr. Langdon's contentions. Then Major Cardew could submit a further draft of the clause, and the Board of Trade would consider it, if necessary, in further conference with Mr. Langdon.

Mr. Langdon said he was quite satisfied for the matter to be dealt with in that way.

Several additional proposals to the draft regulations were next considered.

The Institution of Electrical Engineers proposed :—"In any case where overhead lines are used the company shall erect and maintain in good order a guard wire in such a manner as to prevent any previously erected wire or wires from coming into metallic contact with the conductors carrying the tramway current."

Mr. Morse moved that the words "where necessary" should be inserted after the sentence "the company shall."

The Chairman pointed out that the Board of Trade had their regulations and used them for the protection of the public, and the proposed additional regulation seemed simply for the protection of the individual. He did not object to it, but it would seem to be more practical in the regulations for the public safety.

Mr. Winterbotham said the regulation was to prevent injurious interference with their apparatus.

The Chairman: You may be certain a guard wire will be there.

After further discussion, the Chairman said he would consider whether the suggestion came in there properly or in the regulations for the public safety, and he would take care that the words "where necessary" should be inserted in any case.

The Associated Railway Companies had given notice of additional proposals as follows :—(1.) "That the most effectual means of preventing interference with the railway wires will be found in laying the "line" and "return" traction wires on insulated supports within a metal culvert, the joints and section of the said culvert being of such a character and section as shall ensure a perfect return to the generating station for the traction currents should such, from defective insulation or other causes, pass into it." (2.) "That where an overhead wire or wires are used for conveying the current to the tram car, the pillar, pillars, or other supports carrying such wire or wires shall be so connected electrically with the return circuit of the said tramway, as to convey to it, without loss, any and all such currents as may escape from the insulator or insulators by which the conducting wire or wires are attached to the said pillars or supports." (3.) "That where two overhead wires are employed, the one for the outgoing and the other for the return current, the supports for the same shall be so electrically connected that any current escaping from the one shall be conveyed to the other without any portion of the same passing to earth."

Mr. Langdon said that, in reference to the first proposal, he understood that under the direction of the Joint Committee the chairman had little scope in the matter. They quite recognised that if the system adopted involved the use of iron conduits and sections

properly joined together, all the interference would be avoided because the conduit would carry it on. He merely wished to place the proposition on record.

The Chairman said his opinion was, that they were tied by the recommendations of the Joint Committee. The other propositions had to do with the point they had had under discussion, and which would be enquired into by Major Cardew.

An additional proposition by the Railway Companies: "That where the route of the tramway is circuitous the return wire shall be aided by insulated feeders," the Chairman said that was provided for in the regulations.

Mr. Langdon said the next proposition was one on which the Chairman had said he was not there to legislate on, and he would only put it forward with the object of its being placed on record. The suggestion was: "That having regard to the fact that any failure in the electrical conductivity of the traction conductors, culverts, poles or brackets, &c., may prove the occasion of interferences with neighbouring block signals, the wires of such block signalling instruments should be dissociated from the earth as far as possible; and that in common justice the cost incurred by the railway companies in consequence of these or other precautionary measures in order to provide, as far as possible, against the incursion of the traction currents, should be borne by the traction authority concerned."

Mr. Monier Williams, on behalf of the Gas Light and Coke Company, then put in the following observations: "We observe that the regulations proposed do not contain any prohibition forbidding connections with gas pipes, and also contain an express permission to use, in lieu of two earth connections to the negative terminal of the generator, one connection with the water main. The company venture to suggest the advisability of inserting such a prohibition as above referred to, and in support of this suggestion they desire to refer the Board to the evidence given before the Joint Committee of both Houses on electric powers (protective clauses) by Major Cardew, Sir Frederick Bramwell, Dr. J. Hopkinson, Professor Dewar and others, which in the view thereof taken by the company, entirely justifies, if it does not do more, such a prohibition; the company also hope the Board will, at least as regards the metropolis, re-consider the advisability of permitting connections to water mains, and would refer to the same evidence in support of this proposition. In the metropolis the confusion existing between water mains and gas mains and other subterranean works in the street is so great, and the propinquity between water mains and gas mains is so close that the electrical use of water mains inevitably carries with it the use of the gas mains, and consequently great danger to the public. The company desire further to place before the Board the necessity of treating the metropolis differently to the extra-metropolitan parts of the country, and, in particular, that the use of uninsulated returns should be entirely prohibited in the metropolis, excepting places where the Board of Trade should, after a full investigation of the special circumstances, see fit to sanction the use of such returns. In many, if not in most streets in the metropolis the subsoil is crowded with mains and works of gas, water, electric, hydraulic, and other companies and of sewage authorities. Amongst other inconveniences, too obvious to need comment, this state of things carries with it a very great liability to frequent subsidences, the formation of cavities, sometimes of great extent, and frequent leakage of gas mains; these subsidences, cavities, and leakages are, for the most part indiscoverable and not to be prevented by any possible precautions, and often are discovered only after injurious consequences have arisen; explosive mixtures are liable to be formed in these cavities and in sewers, particularly the numerous disused sewers, and frequently the gas travels long distances from the seat of the original mischief. Of these matters this company has had only too frequent experience, as well as of the practical difficulty of coping with the dangers so created in an adequate and effective manner. The company are, therefore, led to very earnestly deprecate the permitting of anything likely to intensify or increase the danger to persons or property in crowded centres, such as the metropolis contains, and uninsulated or defective insulated conductors of electric currents cannot but be regarded, the company are advised, as likely sources of danger. The company desire to express the hope that the Board will take these observations into consideration and re-consider the question of permitting uninsulated returns in the metropolis. The company further observe that clauses (2 and 3) of the clauses to be inserted in all Bills and Provisional Orders limit the protections against injurious affection of gas and water mains, and the regulations to be made by the Board to fusion and electrolytic action. The company venture to suggest the desirability of, in practice, extending the powers to provisions against other modes of injurious electric action. Clause 4 of these clauses imposes, in very sweeping terms, a single penalty with a further daily penalty in case of a continued offence for any breach of the Act, Order, or Regulations. The company are advised that this clause would seem to defeat the object of the Joint Committee, inasmuch as unless the legal right to recover compensation in the shape of damages is expressly reserved to persons injured by the Undertakers' Acts, or neglects, the courts might, on the authority of decided cases, hold that the sole remedy for or consequence of any breach of the Act, Order, or Regulation was the recovery of the penalty, and that the recovery of damages by an injured party was excluded. So that if the Undertakers chose to risk the imposition of a penalty, and not necessarily the full penalty, they would enjoy a practical immunity and the most effectual deterrent, viz., the liability to suffer in damages would be excluded. The company desire us to draw attention to this aspect of the clause with a view to the Board's future opportunities of action in the matter."

Mr. Monier Williams said that while he hoped, in connection with Clause 4 of the draft regulations, that the Board would give them protection where permissive power was given to connect with water pipes, he did not think that sufficient. As regarded any damage caused there, he took it that the Chairman would be against them.

The Chairman said he would consider the matter further, but at present his impression was that they had no power to do anything with respect to that matter.

Mr. Monier Williams then suggested the following additions to Regulation 4: "Provided always that before allowing any departure from a modification of this regulation such officer of the Board of Trade shall give to any gas or water company having pipes in the vicinity an opportunity of objecting thereto, and of appealing to the Board of Trade, who shall hear and adjudicate upon such objections by an arbitrator appointed by the Board in the usual way."

The Chairman said his objection to that was that it put on the Board of Trade the duty of hunting up objections. He was perfectly ready to make it the duty of the Board to consider any objection sent in.

Mr. Williams said he would leave it entirely in their hands.

The Chairman: We will consider it.

Mr. Morse said he supposed that those regulations were to be added to clauses to be inserted in future bills.

The Chairman said he was not sure about that.

Mr. Morse said that what he wanted to say was that a great many of the tramway companies had electric powers granted them by bills previous to the sitting of the joint committee, and those regulations might be rather difficult to interpret when the companies came to apply electricity.

The Chairman said he was considering that point with the authorities of the House at that moment. He thought the clauses would have to be inserted in every future tramway bill.

Mr. Morse asked how they would deal with the tramways who already had their Acts, without those clauses, when they came to equip themselves electrically.

The Chairman said he thought they would recite the clauses in the regulations.

Mr. Morse asked if the Board of Trade would bring in an Act and make them applicable to the Bills already passed.

The Chairman said if there was a desire on the part of the tramways of sufficient weight to have a joint act embodying those clauses, the Board of Trade would consider it, but before pressure of sufficient strength came before them they would not be able to act.

Mr. Morse said of course he understood the necessity of not acting without a strong request, but it was a question of a hundred companies moving where one Act would cover the whole question.

The conference then ended.

ELECTRIC SIGNALLING WITHOUT WIRES.

By W. H. PREECE, C.B., F.R.S.*

If we take a conductor through which a rapidly alternating current is being supported by any means, it throws the ether which surrounds it into oscillations. Energy is thus radiated away in electric waves. These electric waves spread out in all directions, as do waves of light, and if they fall on similar conductors properly placed and sympathetically prepared, these waves of energy are transformed back again into alternating currents, which give evidence of their presence. Their presence is indicated by a telephone, if the frequency of the alternating currents is brought within the range of the ear.

The prime source of energy has been either a steam engine or a galvanic battery. This has produced, by suitable machinery, rapidly intermittent or alternating currents, which have been transmitted through a primary circuit. At some distance away from this circuit there has been a secondary telephone circuit, and between these two circuits the only connecting medium has been the ether, which has been thrown into electric oscillation, and it has been across this space that I have been signalling without wires. In all cases the primary currents were of such a frequency as to produce a musical note in the telephones fixed in the secondary circuit, which could easily be read, if sent in the dots and dashes of the Morse code.

In 1884, messages sent through insulated wires, buried in iron pipes in the streets of London, were read upon telephone circuits erected on poles 80 feet away on the housetops. It was imagined this must have been due to accidental connections, or to earths, or to any other cause but the true one, namely, electro-magnetic induction, or the influence which one conductor conveying currents exercises on another parallel to it, when separated by a dielectric, or by mere space, that is, by the ether.

Ten years of experiment have proved the effects I am bringing before you to be due, primarily, to radiation, and not to conduction.

In 1885, a very exhaustive series of experiments was made for me by Mr. A. W. Heaviside, in the neighbourhood of Newcastle, to find out how far the distance between the wires affected the results. Ordinary telegraph working currents produced disturbances at a distance of 2,000 feet, while effects on parallel lines of telegraph, 10½ miles apart, between Durham and Darlington, were perceptible. Distinct speech was carried on through a distance of one quarter of a mile. We even obtained indications of current between the east and west coasts, 40 miles apart, but these observations were vitiated by conduction through the large network of telegraph wires between those two places. I brought the subject before the British Association at their meeting in Birmingham in 1886. The district between Gloucester and Bristol, along the banks of the River Severn, was then selected, where for a length of 14 miles, and at an average distance apart of 4·5 miles, no intermediate disturbing conductors existed. I was able to experiment with complete metallic circuits, the return

* Abstract of paper read before the Society of Arts, February 21st.

wires passing far inland, in the one case through Monmouth, and, in the other, through Stroud. Weak disturbances were detected. These experiments were repeated, with more experience and greater success, in 1889. Similar experiments were conducted along the valley of the Mersey. A new trunk line of copper wires that was being erected between London and the coast of North Wales was then experimented upon, and some interesting results were obtained in the district between Shrewsbury and Much Wenlock, and between Worcester and Bewdley.

An admirable series of experiments were made for me in the same year by Mr. Gavey, near Porthcawl, in South Wales. There we have a wide expanse of sand well covered by the tide and giving the opportunity to observe the effects in water as well as in air. Squares of insulated wire, 1,200 yards long, were laid side by side at various distances apart, and smaller squares were suspended above each other on scaffold poles. The effects were observable equally in air and water. The results were absolutely conclusive that we were working with the so-called electro-magnetic induction, and all subsequent experience has confirmed this conclusion.

These further experiments were brought before the British Association at Manchester in 1887.

Thus the theory of the thing had been thoroughly threshed out, and it only waited for some convenient opportunity to give it a practical test.

When the Royal Commission to enquire into electric communication between the shore and lighthouses and light vessels was appointed in June, 1892, the question was started. Here was the opportunity. My proposal to test this means of communication in a practical way was submitted by the Postmaster-General to the Treasury. The expenditure was sanctioned, and the experiment made. The results were submitted by me to the Electric Congress which was held in Chicago in August in 1893.

The Bristol Channel proved a very convenient locality to test the practicability of communicating across a distance of three and five miles. Two islands, the Flat Holm and the Steep Holm, lie off Penarth and Lavernock Point, near Cardiff, the former having a lighthouse upon it. On the shore two copper wires weighing 400 lbs. per mile, forming one conductor, were suspended on poles for a distance of 1,267 yards, the circuit being completed by the earth. Experience justified the assumption that the earth acts as a conductor, and that it practically replaces the fourth side of the rectangle used in the previous experiments. We have not yet determined the actual position of the resultant line of this earth side, but further experiments are being made. On the sands at low water mark, 600 yards from this primary circuit, and parallel to it, two ordinary gutta-percha covered copper wires, and one bare copper wire, were laid down, their ends being buried deep in the ground by means of bars driven in the sand.

One of the gutta-percha wires was lashed to an iron wire to represent a cable. These wires were periodically covered by the tide, which rises here at springs to 33 feet. On the Flat Holm, 3·1 miles away, another gutta-percha covered copper wire was laid for a length of 600 yards.

There was also a small steam launch, having on board several lengths of gutta-percha covered wire. One end of such a cable, half a mile long, was attached to a small buoy, which acted as a kind of float to the end, keeping the wire suspended upon or near the surface of the water, while the launch slowly steamed ahead against the tide. It was paid out and picked up in several positions between the primary circuit and the islands.

The apparatus used on shore was a 2 horse-power portable Marshall's steam engine, working a Pike and Harris's alternator, sending 192 complete alternations per second at a voltage of 150, and of any desirable strength up to a maximum of 15 ampères. These alternating currents were broken up into Morse signals by a suitable key, and sent along the primary circuit. The signals received on the secondary circuit produced sound, and were read on a pair of telephones—the same instruments being used for all the experiments.

The object of the experiments was not only to test the practicability of signalling between the shore and the lighthouse, but to differentiate the effects due to earth conduction from those due to electro-magnetic induction, and to determine the effects in water.

It was possible to trace, without any difficulty, the region where the signals ceased to be perceptible from currents, due to earth conduction, and where they commenced to be solely due to electric waves. This was found by allowing the paid-out cable, suspended near the surface of the water, to sink. Near the shore no difference was perceptible, whether the cable was near the surface or lying on the bottom, but a point was reached where all sounds ceased as the cable sank, but were recovered again when the cable came to the surface.

The total absence of sound in the submerged cable rather surprised me, and it leads to the conclusion, either that the waves of energy are dissipated in the sea water, or else that they are reflected away from the surface of the water like rays of light. I believe implicitly in the latter explanation. Subsequently, experiments on the sands in the Conway Estuary showing the relative transparency of air and water to these electric waves, tend to support the latter deduction for if waste of energy took place in the water, the difference would be more marked than was actually found to be the case. It was 6 per cent. only. As it is, we have ample evidence that the electric waves are transmitted to considerable distances through water, though how far remains to be found out.

There was no difficulty in communicating between the shore and Flat Holm. The distance between the two places was 3·1 miles. The attempt to speak between Lavernock and Steep Holm was not so successful. The distance was 5·35 miles, but though signals were perceptible, conversation was impossible. There was distinct evidence of sound, but it was impossible to differentiate the sounds into Morse signals. We were just on the limit of audibility, and we were using our available maximum power. If either line had been longer, or the primary currents stronger, we should have spoken as was done at Flat Holm.

As the laws governing these effects were by no means so clear and conclusive as such probing and enquiring deserved, Mr. Gavey and Mr. Kempe conducted for me a very careful series of experiments near Frodsham, on the estuary of the Dee, which was found to be a more convenient locality than Conway, and the very satisfactory results obtained will shortly be published. The conditions are now so clear that, given the localities between which it is desired to communicate, it is a mere matter of calculation to show what has to be done. It would be quite easy to speak between France and England across the Straits of Dover.

There happens to be a very convenient and accessible loch in the Highlands—Loch Ness—forming part of the route of the Caledonian Canal between Inverness and Bannavie, having a line of telegraph on each side of it. Five miles on each side of this loch were taken and so arranged that any fractional length of telegraph wire on either side could be taken for trial. Ordinary, and not special apparatus was employed, sending messages, as before, by Morse signals, and speaking by telephone across a space of 1¼ miles was found practical, and, in fact, easy; indeed, the sounds were so loud, that they were found sufficient to form a call for attention.

The following apparatus was in use on each side of the loch for the transmission of Morse signals:—A set of batteries consisting of 100 dry cells, giving a maximum voltage of 140; a rapidly revolving rheotome which broke up the current into a musical note; a Morse key, by which these musical notes could be transformed into Morse signals; resistance coils and ampère meters to vary the primary current; two Bell telephones joined in multiple arc to act as receivers. For the transmission of actual speech simple granular carbon microphones, known as Deckert's, were used as transmitters, and a current of 2 ampères was maintained through these and two Bell telephones in circuit with the line wire.

Any lingering fear that earth conduction had principally to do with these results was removed by making the earth's terminals on the primary circuit at one end at Inverness nine miles away, and at the other end in two directions in a parallel glen about six miles away. The early experiments of 1886, in the valley of the Severn, had placed this question of earth interference beyond the region of doubt, but earth conduction, as a main factor in the results, is still believed in by critics. The function performed by the earth has been thoroughly developed in the Frodsham experiments, and will be discussed subsequently.

One very interesting fact observed at Loch Ness was that there was one particular frequency in the primary circuit that gave a decided maximum effect upon the telephones in the secondary circuit. This proves the presence of resonance, and is, of itself, a fact sufficient alone to prove the effects as being due to the transformation of electric waves into electric currents.

It is well known that every telephone has one particular note—the natural note of the disc—to which it responds better than to any other, but this resonant effect far exceeded in magnitude any difference due to the natural pitch of the disc. It was not the natural note.

Conversation by telephone, though possible, was not, however, practical. Still, it is something to have transmitted speech by electricity across an air space of 1¼ miles. We had this curious condition, that at some intermediate point the energy of the human voice was found side by side in two different forms—sonorous vibrations in the air, and electric waves in the ether.

There is now no difficulty in communicating with outlying islands if the conditions are favourable, as we have now acquired a practical system of signalling across space without the necessity of using wires.

If any of the planets be populated with beings like ourselves, having the gift of language and the knowledge to adapt the great forces of Nature to their wants, then if they could oscillate immense stores of electrical energy to and fro in telegraphic order, it would be possible for us to hold commune by telephone with the people of Mars.

JABEZ AS BOGEY.

THERE was a time when the mention of "Boney" inspired the youthful mind with awe and extorted unwilling complaisance. A certain Mr. McCarthy, late book-keeper to the Electric Construction Corporation, seems to have thought that the name of Balfour had a similar potency, and that the directors of that company were children. His calculations were not justified by events. It was this way: a certain Mr. Tarver owed the corporation money and paid them by acceptances of the Building Securities Company, depositing as collateral security 1,200 E.C.C. shares, together with a transfer. On the failure of the London and General Bank, with which Mr. Tarver was known to be connected, the directors, fulfilling an obvious duty to their shareholders, utilised the transfer and placed the shares in the names of their chairman and vice-chairman; and when the Building Securities Company stopped, too, they arranged to realise their security. As, however, the selling on the market of shares out of the names of officers of the company might have led to the belief that those gentlemen were pouting with their own shares, and the shareholders' interests might thereby have suffered, the shares were placed for sale in the name of a Mr. Bromham and sold; but an objection of a somewhat similar nature attaching to that gentleman, Mr. McCarthy was asked to sign transfers of these shares into and out of his name. The shares realised £2,234 7s. 6d., and were paid for by a cheque to McCarthy or bearer, which was sent to the corporation and passed by

them into their banking account. The amount was entered in the cash book as money received from Mr. Bromham; and when the cash book, some time afterwards, came before McCarthy, whose duty it was to post it, he altered the entry, making it "McCarthy per Bromham," and posted it to the credit of a ledger account in his own name, which he opened for the purpose. In June, 1893, on a review of the ledger balances, he was asked for an explanation and requested to amend the entry. His proposals as to the mode of amendation were unsatisfactory: a month's salary was given him and he was requested to leave the office forthwith. A few days after leaving he issued a writ on the Corporation for the £2,234 7s. 6d., which he claimed as his own, and the action was tried in the Mayor's Court on the 22nd inst., before the Recorder (Sir Charles Hall, Q.C.) and a special jury.

There is nothing wonderful in the above story, except the confusion existing in the plaintiff's mind. That any man should have thought, under the circumstances, he had any claim whatever is marvellous; but that he should have fancied it possible to persuade a judge and jury to think so too was more so. His statement was that at the time when he was asked to sign the transfers, he pointed out that originally the calls on the shares had been paid for by bills, and that if these shares had not been met by cash at maturity, but renewed from time to time, there would be a liability attaching to the shares and a certain amount of risk, whereon he was told by the then secretary that he could take the shares in consideration of the risk. He did not, however, call the said secretary as a witness.

Mr. Kemp, Q.C., the defendants' counsel, submitted that there was no case to go to the jury, but the Recorder thought there was a case, although a poor one, and accordingly Mr. Kemp addressed them and was proceeding to put his witnesses in the box, when the jury stopped the case on the plaintiff's evidence and gave verdict for the defendants.

Some side lights, curious and interesting from a psychological point of view, were developed as the trial proceeded. In answering interrogatories, the plaintiff had declined to give certain information until the trial, stating that in the meantime it would be sufficient to mention the name of J. Spencer Balfour. It was an unlucky remark, which Mr. Kemp handled with effect. This, then, was the fount and origin of the action. The idea of it being brought prominently before the public in a court of law, that the directors of the Electrical Construction Company had been associated with the discredited exile languishing at Salta, who had left his country for his country's good, would have had such a horrifying effect upon those gentlemen that they would incontinently have squared the matter before it came into court; or, perhaps, the jury thinking of that naughty man would have considered every bird which hopped in the same garden to be of the same feather.

Mr. McCarthy had sworn that, mentioning the circumstances of the shares to a friend, that friend had advised consulting an acquaintance of his named Foster, that this Mr. Foster asked him if any large sums of money passed through his hands, and recommended him to stick to the amount of his claim. Mr. Kemp, however, stated that Mr. Foster was prepared to swear that the plaintiff had sought his advice as to whether it would be a criminal act to so deal with any of the company's funds, and had asserted that he intended so to deal with them. That the case was stopped before this witness could go into the box was somewhat of a pity, as it most likely precluded a very pretty piece of hard swearing to diametrically opposite statements which would have been developed. There was a time when hard swearing was mostly connected with horse cases, but now that we have company cases the incidence has changed, the latter having a great advantage in expert witnesses—but this by the way.

There are several morals to be drawn from this little difference of opinion between an electrical company and its clerk. It is not wise to accept from another man as a present that which he has no right to give you; nor to put your own brand on another man's heifer, and then think it is yours. Also Balfour as Bogey is exploded. We cannot help thinking his godfathers and godmothers are to some extent responsible for this, and that it has been one of the greatest of consolations to many who have suffered by him whom they adored as Mr. Spencer Balfour, M.P., to be able to refer to him as Jabez. Moreover, it has been laid down by high legal authority that to have consorted with him, and with others of his friends, the latter of whom are doing time, is not to be flaunted in one's face. He was once a company demi-god and sainted man, and, as such, a proper companion. It was not until he fell, like Lucifer, never to rise again, that he became "Jabez."

CORRESPONDENCE.

Telegraphic Communication between England and India.

With reference to your notice in the last issue of your journal of my paper on "Telegraphic Communication between England and India," I should like to put the following figures before you to show the main argument of my paper was founded upon facts, and does not rest solely upon supposition. On January 1st, 1876, the minimum chargeable unit for telegrams between Europe and the East was reduced from ten words to one word, the latter to consist of not more than ten letters. What was the immediate effect of this reduction? In the year 1876-77, the average value of such messages decreased 12 per cent., but private senders despatched 22·44 per cent. more messages, and the gross value of the traffic increased by 5·34 per cent. In the year 1877-78, the number of messages increased by 34·14 per cent., and the gross value 27·28 per cent.

Again on May 1st, 1891, the rates to New South Wales, Victoria, South Australia, and New Zealand, were reduced by one-half. The Eastern Extension Company lost by this £55,040 in the first year, and £43,558 in the second. On January 1st, 1893, 9d. was added per word, to insure against further loss, the rates then being, for New South Wales, 4s. 11d., Victoria, 4s. 10d., South Australia, 4s. 9d., and New Zealand, 5s. 2d. In your issue of November 3rd last, you will find Sir John Pender's remarks upon the ultimate effects of the reduction in rates; he says: "during the current or third year of the guarantee, the losses would, as far as they could at present judge, be comparatively nominal, owing to the additional 9d. that was added to the tariffs at the request of the colonies having come into force January 1st last." So that in three years the increased traffic consequent on a decrease in the rates by almost one-half, has protected the company against further loss. If the rates had been gradually lowered, it is plain that there need have been no loss. We must not lose sight of the fact that Sir John Pender in referring to the year 1893 for his calculated results is treating of an exceptionally bad trade year. His figures, therefore, lend particular force to my argument. You say that "the advent of the 6d. telegram in England has certainly not resulted in such an enormous increase of traffic as many prophesied"; but you must not forget that the telephone has largely discounted the effect of the introduction of that cheap telegram. India offers a better example of an increase in traffic resulting from reduction in price. We have in India, too, a country which is in course of continual development and of an expanding trade; proportionately its progress is quicker than that of the United Kingdom is now. Up to January 1st, 1882, a telegram in India cost one rupee (worth then about 1s. 8d.), on that date the "deferred" class of message, costing eight annas (about 10d.), was introduced. This message was usually sent off in the afternoon or evening and was delivered next morning at daylight. It certainly did attract a large number of customers, for in 1881-82, private messages in India were 1,035,137 in number, and Rs.1,316,851 in value, and after the reduction in cost, in 1882-83, 1,539,975 in number, and Rs.2,618,298 in value.

Speaking generally, if it be desired to make the use of an article universal, the cost of it must be gradually reduced. If it be a good and useful one there will arise a greater demand. I maintain that this argument applies to telegrams between England and India. We have never known anyone in the latter country who has adopted the telegraph for use in business give it up in favour of his old mode of communication through the Post Office, but have found rather that the time he has gained, and the quicker profits he has made, incline him to a more frequent use of the wire.

E. O. Walker.

February 23rd, 1894.

Cosmical Electricity.

The comments which you make in your issue of January 26th concerning my talk on cosmical electricity are in part due to the fact that you were not in possession of the full text of my remarks, and I admit that some of your objections to the views presented may appear at present to be well taken.

One objection you make is that the views presented are not "science." In opening my remarks before the section of the Franklin Institute, I was particular to point out the difference between science and speculation, and laid stress on the fact that what I should say would come under the head of speculation. I was particular to point out that the theorising was crude and amounted to a species of guessing, or "thoughts" merely.

I know of no rule which forbids the use of the imagination forming a hypothesis or speculation, provided we do not confound such process with science properly so called.

Some other of your objections do not appear to me so insuperable, and some again were taken account of as will appear when the full text is at hand.

Concerning your reference to "the bias of the electrician who wants to explain everything by electricity," I desire to say that, in my opinion, if anything in Nature is found unexplained, it may be high time that an attempt be made to fit an electrical hypothesis to the case, especially if a plausible one be found, and then allow time and tests to decide whether it shall survive or not. If any plausible explanation, not electrical, can be suggested, let it come also to the test. I must confess to a "bias" for trying to understand facts and phenomena presented to my consciousness.

Elihu Thomson.

The First Three-Phase Transmission Plant in the United States.

Your article on "The First Three-Phase Transmission Plant in the United States," in your issue of 16th inst., does not in the least exaggerate the importance of the subject it deals with. In one point only would I venture to direct your attention to an oversight, which, with your well known fairness, I am sure you will correct.

The honour of the first transmission plant in the United States belongs to Rock Creek, El Dorado Co., California, designed and constructed by Mr. G. Cullen Pearson and Prof. Keith, of San Francisco, in 1890, which I saw in full operation the following year, a description of which was published in the *Mining and Scientific Press* of San Francisco, January 23rd, 1892, a copy of which I beg to hand to you for your information.

Sam Jennings.

Balancing in a Three-Wire Station with only one Machine Running.

I have read with much interest Mr. Gibson's scheme in your last issue on the above subject. The chief difficulty in a generator with two armature windings, revolving between the same pair of magnets, is that the relation between the E.M.Fs. generated by the two armatures is necessarily constant; and if the two armature windings each consist of the same number of turns, the two E.M.Fs. will always be equal. The voltages at the terminals of the two pairs of brushes may vary slightly owing to the copper resistances of the armature coils when the load is not the same on each armature; but the armature which has the lesser load will, if anything, have the higher voltage at its brush terminals, whereas it was shown in the description of the Burnley central station that the less-loaded side of the three-wire system required the lesser E.M.F. Now, if these double-wound generator armatures are connected directly on to the bus bars as suggested, it will be impossible to regulate the E.M.F. on one side of the system, without varying the E.M.F. on the other side to the same extent, unless series resistances are used. Shifting the position of the battery switches shown at the bottom of the diagram will produce no effect on the feeders, as the pressures on the two sides of the system will always be the pressures of the two armatures. The only result of moving the battery switches will be in varying the charging or discharging currents of the batteries. The charging current could certainly be varied at will with this arrangement, independently of the external load, and it would be quite unnecessary to continue charging one side of the battery after the other is shut off, as suggested by your correspondent. But it would be impossible to produce anything but an approximately equal E.M.F. on each feeder at the station, which means that there would not be an equal E.M.F. on each feeder at the feeding point.

The only way in which the latter result could be obtained with the proposed apparatus would be by connecting the generator armatures on to the charging switches, and the feeders on to the discharging switches, when the E.M.F. of either feeder could be varied as required, by moving the battery switches. But this entails putting the whole load of the station through a part of the batteries, which is, of course, out of the question.

With the arrangement adopted at Burnley it will be seen that it is never necessary to put more than half the current in the balancing wire through the batteries. The reference to a "compensator—as a 4-ton machine using 7 or 8 B.T. units per day and several gallons of oil per week," should read in the case of the Burnley machine as follows:—"A 2-ton machine using 5 or 6 B.T. units per day, and about one gallon of oil per annum."

Apologising for such an extended trespass on your valuable space,

F. Thursfield.

Burnley, *February 24th*, 1894.

The Electro-Chemical Company.

In the current number of your journal there is an allusion to the recently formed Electro-Chemical Company. I had not previously seen your former reference to this matter, but having gone through some of the back numbers of the Electrical Review, I find that in the issue of December 22nd (not, as you say, in the last number of the year '93) you criticise a prospectus which about that time was looked upon as such a private and confidential document that even I, being one of the consulting engineers to the Trust, was requested to return it after perusal. Will you kindly tell me how it came about that you saw a copy of the draft in question?

Wm. H. Massey.

[We regret that we cannot grant Mr. Massey's request. Seeing that his name has been published for 2 or 3 years past, we believe, as one of the consulting engineers of the Trust, it is odd that he should have missed the article to which he alludes. The company's shares having now gone to allotment, we can but watch, with something more than ordinary interest, the future developments of the Electro-Chemical Company, and this we shall not fail to do.—Eds. Elec. Rev.]

The Heilmann Electric Locomotive.

I am not particularly desirous at present of maintaining the absolute or comparative virtues of the Heilmann locomotive, for one reason, because the chief supporters of that appliance are quite capable of "keeping their end up"; and for another reason, because my own judgment upon the probable efficiency of the whole contrivance is suspended (as mentioned in my article in the *Electrical Engineer*), until exact figures and facts of the tests are published by the officials of the Chemin de fer de l'Ouest.

In your leader of last week's issue, however, there are several distinct points of criticism, more particularly concerning myself and the personal opinions expressed in my article, that I shall ask for some of your space to reply, although the topics discussed are perhaps of more interest to railway men than electrical engineers.

In the first place, I am not altogether surprised at any one regarding the Heilmann locomotive as the embodiment of a roundabout method of driving a set of axles. I felt that way myself, a year or two ago, when the details of it were first published. Doubtless you will get over it in due time, especially if you assign even approximate values in £ s. d. to the pros and cons, and draw up a balance sheet of efficiency. Let me put it in this way: An ordinary steam locomotive burns, at least, from 4 to 8 lbs. of coal per horse-power hour, all told, firing up, running, and standing idle. Any decent fixed compound engine ought to do better than this; but assuming, say, an average consumption of 4 lbs., a total efficiency of only 70 per cent. in the electrical equipment will not raise this to more than 6 lbs. There are confessedly *some* advantages in the abolition of side rods and engine motions under the frame of boiler, where they are exposed to dust and dirt—highly conducive to frictional losses. I merely suggest this as a slight justification for examining the appliance in an unbiassed way.

When travelling on the foot-plate I was careful to notice that the Heilmann locomotive had practically no vibration whatever. The main engine is set *across* the frame, and even with its obvious defect of short stroke did not cause lateral or perpendicular movements of the framework in any way. Indeed, the only other locomotive upon which I have ever had a run approximately as steady, was one of Mr.

Worsdell's big 90 ton compounds on the North Eastern between Newcastle and Edinburgh. With regard to the matter of increased adhesion, of course I know that this is principally of service at starting and running up grades, *i.e.*, when the speed is low; but then trains are not always on the move, they are obliged to pull up more or less frequently, and the average railway is by no means on a dead level. The Great Northern use single-driver express engines because the grades are easy; but on the more hilly Midland every railway man looks astonished at Mr. Johnson's big single-drivers being able to pull trains at all. I doubt whether they would without steam sanding pretty copiously.

Surely you cannot be in earnest in suggesting the use of endless ropes as a means of obtaining the advantages of a flexible connection between the steam motor and driving wheels! The idea of a set of ropes, flapping around in the dust and dirt, does not convey to my mind the feeling of sound mechanical design, and the 'less loss of efficiency' thereby incurred I should most strongly doubt. As to the question of a high centre of gravity, what I said was, that the influence of a high C.G. made itself more especially felt when rounding curves at high speeds. The super-elevations of outside rails are, of necessity, calculated for the *average* train speed on any line, and, when high velocities come into use, I am not so sure but what I would prefer the C.G. to be 10 feet *below* the rail level rather than 10 feet *above* it. Perhaps that idea of a trough for the centre of gravity has more in it than you fancy; it is at any rate what one would find on a high speed telpher line, or on a railway constructed after the Lartigue principle.

The Editor of the *Electrical Engineer* is doubtless able to bring an appropriate weapon to bear upon those guilty of the "works of art" which accompanied my article; I hardly need to disclaim responsibility for them. Your description of the new locomotive, by the way, is the most apt I have yet seen, and a month's talk would give no better definition in such few words. It *exactly* resembles a box car tacked on to a side-tank engine.

I don't understand your last paragraph. Mons. Heilmann is the managing director of the syndicate or company of Paris and other financiers who have undertaken to construct the locomotive; but that he is also managing director of the railway (by which you must mean the Chemin de fer de l'Ouest), is news to me, and probably also to himself. I may be wrong, but doubt it; at any rate it is a pity that imputations should be made unless well founded. They say that a certain person quotes Scripture for his own purposes: I should be sorry to see the ELECTRICAL REVIEW following a bad example with a Latin tag.

Frank B. Lea.

Electric Lighting of Steamships.

With reference to the suggestions put forward by Mr. Rankin Kennedy in your issue of 16th, on the above subject, there are one or two points which I should like to pass a few remarks upon. The objections to single wiring, Mr. Kennedy contends, are only "theoretical, and not to be found in practice." My experience of 10 years with over 200 vessels, in both single and double wiring, has not passed without seeing defects in both systems, but I have no hesitation in saying that the single wiring is far more troublesome, and liable to cause fires, than the double wiring. That it does affect the ship's compasses is conclusively proved by your correspondent, Mr. Muitt, in last week's issue. Notwithstanding that, I can name certain single-wired ships actually using electric lamps to light the binnacles, and fitted by the captain and officers themselves. There are, however, other serious dangers in single wiring to be considered, chiefly from the earth wires being put behind panelling and other woodwork to get to the iron of the ship, and, as it is well known, these places very soon become damp and saturated with sea water, and the sweat thus formed soon corrodes the wires, the copper very often turning into a mass of green fungus. I have known such wires create smells of burning, which puzzled the officers of the ship to know where it was coming from. The weakest point of all is, perhaps, the iron screw with brass washers to bind the wire to the iron, where the sweat is constantly trickling upon it. This is a difficulty that cannot be very well got over, and is a most serious objection to single wiring. I have also seen some narrow escapes from fire through double wiring, which were generally due to water causing partial short circuits. It matters very little what class of insulation you may use; let it be ever so good, it will soon decay if sea water is allowed to drip upon it. In a previous issue wood casing was condemned, and armoured wires suggested by Capt. Froud as a sure preventitive of this happening; but that is not my experience. I have found where armoured wire was exposed in any way, it stood little better than good teak casing. If care is taken to fix the wood casing in sheltered positions, keeping it clear of all skylights and openings, and placing it outside of all other work, with covers facing downwards, it stands as well as anything that could be used, and in some vessels now running for the last five years, the wires and casing will be found as fresh as the day they were put in, and has not cost the owners a single penny for repairs. To obtain this, however, one must know the weak points of a ship, to avoid all possible places where water is likely to come in. Where the wires must pass through exposed parts, they should be led from distribution boxes, and drawn into galvanised iron pipes, and all couplings made watertight, no joints being allowed in the pipes, and all switches and fuses fixed inside of some sheltered place. I have practised this system for the last few years, and find it to give splendid results. Mr. Kennedy also advocates single wired fittings, and describes the two wires carried into the fitting as "primitive and barbarous." If he had more experience of the two systems, I think he would change his opinion about this. I find ships fitted in this manner continually in trouble, and seldom make a three months' voyage without having a burned backblock, or some of the springs burned up. Take one fleet of steamers here, nine of which are fitted on the double-wire system throughout to the lampholder, and five on the single-wire system, and the superintendent engineer will bear me out in saying that they have not one-fourth of the trouble and expense with the double wiring that they have with the single. In fact, the single wired ships seldom come home without several of their lamps out, and it is invariably found that the fault lies in the fitting or backblock. I think the vibration and lashing about of the ship will readily account for the loosening of screws and contact springs. I see no valid objection to the wires being pulled through the fitting, if the tubes are made large enough not to chafe the wires, and there is no doubt when the wires are fixed to the binding screws of a proper lampholder, it makes a far more substantial and reliable job, and a burned fitting is a rare occurrence. I may add that the burned fittings referred to were fitted up by Mr. J. D. F. Andrews and Mr. Kennedy himself.

Your specimens of jerry wiring are interesting, but it is questionable if the electrical engineer is altogether to blame for this. It is quite a common experience to find that many of these joints are made by the sailors and engineers on board the ship. If a wire breaks or an extension is wanted for another part of the ship, they feel quite proud to be able to put in a "splice" of their own, and your specimens very much resemble some I have had to remove. I do not mean to say that all engineers and sailors make joints in this way, but there is certainly a great want of knowledge in this respect with most of them, and it would be well to impress upon the Board of Trade the necessity of engineers learning more about electric lighting before they grant their first class certificates; a very little extra training would be necessary, and it would be to the benefit of all concerned. It should also be noticed that many of the ships fitted in the earlier stages of electric lighting are in a very dangerous condition, partly from old fittings (such as the wooden switch you illustrate) and defective insulation which are allowed to remain until they actually give way. It is surprising to me there have not been more serious accidents on board some of our Atlantic greyhounds before now. A few years ago I went through some of the famous liners at Liverpool along with a friend; one case in particular was a single-wired ship where the mains passed through a hold where bales of cotton had only been recently removed. Just under these mains was an iron door which had chafed the insulation until the wire was bare, and what might have happened is serious to contemplate. There are other equally glaring dangers which the Board of Trade and Lloyds' surveyors are passing day after day, and yet they take no notice of them.

I am sure all who believe in turning out an honest reliable

job would welcome a strict supervision and periodical tests of the installations by Board of Trade inspectors, such as they carry out in other parts of the ship.

This would possibly be the surest plan of putting a stop to all inferior work.

W. C. Martin.

Glasgow, *February 27th*, 1894.

The experiments of L. Muitt, described in his letter on this subject, do not prove much one way or the other. It is quite easy to run wires with a view to cause a deflection in a compass needle as shown by the experiments, but he does not say how the return circuit was made. And then, again, a current of 100 ampères is never, in any case, run in one main, fore and aft, in any ship. I have never heard of such a thing in practice where 200 lamps were all fed from one main; 20 ampères is about a maximum current in any long main in the ordinary ships. Only a few heavy cables are used with heavy currents from the dynamo to distributing boards, and as these are not far from the dynamo, they don't affect the compass; and neither I nor anyone else, I believe, would ever for a moment propose to run a main 3 feet above a compass or 12 feet below a compass, and carrying 100 ampères. He does not say what was the result of his experiments with double wires 1½ or 2 inches apart, carrying 100 ampères, nor does he cite any experiments made with actual installations on board a ship, the results of which could settle the question.

The question is not what effect a wire carrying 100 ampères would have on a compass, but what effect a single wired installation on a ship has on the compass. My experiments were made with actual installations, and I have four times crossed the Atlantic on single-wired ships without ascertaining any effect on the compasses or hearing of any; and I have been on board single-wired ships at no less than 18 trial trips, and we did not get miles out of our course, either in one instance or another, nor perceive any deflections. Effective and safe installations can be made without adopting the most expensive methods and materials. The various claims made by Mr. Muitt for the two-wire system and his objections to the single-wire system, are points which will come up in the articles on the rules and regulations. I need not, therefore, discuss them here further than to say that a perusal of the articles may change Mr. Muitt's views considerably.

Rankin Kennedy.

The thanks of all who have the interest of the trade at heart are due to you for your very able article in your issue of February 23rd, exposing the pernicious system of jerry wiring, a system, which, unfortunately, is making rapid strides, not only in ship wiring but equally so in house wiring. Your warning protest has not come one moment too soon, and as one who has had considerable experience as a general electrical operative both in this country and the United States, also as general secretary of the Electrical Trades Union, I can endorse every word contained therein, and can accept the illustrations as correct specimens of jerry workmanship. The samples are the reverse of uncommon, inasmuch as far worse specimens are cut out every day in many of the private and business premises in the kingdom. Specimens are continually handed to me by our men, which, if illustrated, would make your specimen (fig. 1) appear in comparison as a piece of neat workmanship. So that it is not only those that travel or are employed on boats at sea that are threatened with this new danger from within, but those who reside on land are equally threatened. There are several causes to which this deplorable state of affairs may be attributable. To deal with each could not be done with justice in one letter without encroaching seriously on your valuable space; still, I trust you will grant me permission to deal briefly with what, to my mind, is the principal cause of this shoddy system, and this is the partiality shown by the majority of employers for the man who will sell his services at the lowest rate, ignoring altogether the question of competence. Of course, I am well aware that employers have to compete with each other for work, usually the lowest estimate being successful; but the present indiscriminate cut-throat competition is largely their own faults. No attempt, as far as I am aware, has yet been made to minimise the evil. We hear of iron, coal, shipping, and cotton associations of employers, but never a word as to an association of electrical engineering contractors. The standard rate (London district) for electric light wireman is 9d. per hour, chargemen 10d. per hour. But the wages paid vary from 4d. per hour to 9½d. per hour for wiremen, and from 5d. to 1s. per hour in the case of chargemen. Bear in mind 4d. and 9½d. is paid for precisely the same class of work; a man will be receiving 4d. per hour from one firm, whilst exactly the same class of work is being carried out in some cases, in adjoining premises, by another firm at the rate of 9d. per hour. The system adopted by the majority of firms in their selection of men is one that is bound to give every chance to the jerry worker. The usual style adopted is to advertise (not in a trade journal) in one of the morning papers for men, either to apply by letter, stating wages, &c., or to apply personally. If the latter, then a certain hour in the day is named, during which the firm will make their selection. Long before the time appointed a very motley crew assemble, much to the annoyance of the neighbours, and to the disgust of the police, who usually are called upon to keep the side walks clear for traffic. If trade is not brisk, between 100 or 200 men can be seen waiting; but in brisk times several score can be seen waiting. Each man is admitted one by one. The first question put to applicant should be put last—that is, "What's your price?" If the price is low he is told to wait outside. The man who asks anything like a fair rate is told he will not do, and so on until they have dealt with the crowd. Then the fortunate or unfortunate (just as you like) men who have offered their services for the lowest rate are ushered into the presence of the advertiser, in order that he may pick out the best from this very poor batch. Thus it is cheapness first—efficiency nowhere. What kind of a workman can a contractor expect if he is going to buy his labour Dutch auction fashion? No self-respecting workman would prostitute himself to such a degrading system. Here are a few examples of the manner in which work is being carried out. Names of firms can be given if required: 1. 60-light job foreman, 5½d. per hour; two men under him 6d. per hour, and five boys, all of whom have paid a premium. 2. Foreman, 8d. per hour (wireman by trade), three gasfitters at 6d., two labourers at 5d. per hour. 3. Foreman (jobbing carpenter) runs cable, has an electrician to make joints; he receives 5½d. per hour, same rate as three labourers on the job. 4. 500-light job, London. Foreman is a tinsmith up to three months' ago, firm sent him out to take charge of job. He receives 7d. per hour; his men receive 8d. per hour. Men work according to tinsmith's orders, refuse to use their own judgment. What sort of a job will this turn out?

One of our members was discharged from a well-known London firm. As usual, we requested a reason for his discharge. Man's reason seemed improbable. I sought and obtained an interview with the head of firm. He said that "he was a very good man, but did his work too well. Evidently he had been brought up by a firm that could well afford to have their work done well, but I cannot, the prices I get will not allow it."

Many of our men have left situations because they refuse to be a party to the shoddy work expected of them. I was applied to a few days' ago by a firm whose advertising tablets can be seen in the City and West End denoting that they carry out electrical installations, for a first-class man, capable of carrying out a large installation complete. I asked if he would have entire charge. "Oh, no," was the reply, "my men (hot water fitters) will have sole charge." Is it any wonder that jerry work is rampant? What the electrical operatives require is a system of voluntary examinations. If it is necessary for plumbers to be registered, it is equally so for electric light operatives. Some such system as that established by the Worshipful Company of Plumbers would be of great benefit—a boon to *bona fide* contractors, a protection for the genuine workman, and a safeguard to the public; and, above all, the death knell to the one hundred and one tin-pot gas, sanitary and hot water engineers, and other botchers, who are at present posing as electricians.

Arthur J. Walker,

General Secretary Electrical Trades Union.

Central Station Engines.

In reply to Messrs. Willans & Robinson's letter, we may say at once that we have neither time nor inclination to enter into a merely personal discussion, as it is our intention to determine the relative merits of the two types in a more practical manner. We will, therefore, confine ourselves to the correction of a few misstatements which Messrs. Willans and Robinson have made, probably from want of the necessary information. We have been building high-speed, double-acting engines for more than 30 years, and our experience in this direction has not been of the limited nature their letter would lead you to infer. At present our speeds *are* higher than Messrs. Willans & Robinson, and we note their concession of steadier running in our favour.

We are willing to concede Messrs. Willans & Robinson the sole right to certain catch words, and have no desire to mislead anyone to assume that our simple and ordinary valve with single "central" eccentric has anything in common with their complicated construction. It is but natural, and we are willing, that they should combat our position, but we cannot allow that we are advocating an *ordinary* double-acting engine, neither can we accept their inference as to the number of working parts and general simplicity, or that we have copied their design of separator, which, as a fitting, is absolutely necessary with a Willans engine and has by habit been included in specifications which we have to adhere to. The configuration of our bedplate is necessarily similar to theirs, but the differences are very important, as our design gives far readier access to all parts of the machine. They did not invent the enclosed case, and the single-acting engine is as old as Watt and Trevethick. The Willans engine did enter the lists against us about 1873 as a high-speed launch engine, but the double-acting engine proved itself as superior for this work as it must, we think, ultimately for electric light work. The amount of work booked in a given period is an uncertain criterion of the excellence of the work, but, as it has been set up as a standard of comparison, we may say that during the last twelve months we have had on order and in progress more than 10,000 horse-power of high-speed engines, and during our long experience in this direction have certainly turned out considerably more engines and horse-power than Messrs. Willans & Robinson.

We repeat that no practical difference can exist between either type in economy. Too much capital has already been made out of laboratory results obtained at Thames Ditton with engines designed and built for such experiments, as it is a subject of common knowledge that laboratory results cannot in any case be attained in practice, and for various self-evident reasons. Messrs. Willans & Robinson may seek to throw contempt on the Admiralty method of testing, but the Admiralty officers are well able to take care of themselves. It would be as well to note here, however, that the Admiralty tests were never intended to be absolute, but simply comparative, and that the conditions of test were common to all makers. On their own showing, Messrs. Willans & Robinson wanted an advantage which would have been unfair to other competitors, but as they have had an equal chance with other makers to show the capabilities of this engine as far as economy and endurance go, and are not now on the Admiralty list for such work, no more need be said.

We will undertake to run our engine for six months on end, or for as long a period as Messrs. Willans & Robinson can do, and the less weight and less complication of moving parts must be largely in our favour for such prolonged runs, moreover, the fact that they advertise a specially strengthened engine is proof that they have a special type for continuous work.

Messrs. Willans & Robinson object to our term "unfortunate," as applied to the history of the single-acting engine, but our data will, we think, justify our use of the term. We fully appreciate the deservedly high position Messrs. Willans and Robinson have taken in their special line. Mr. Willans came forward in the early days of electric lighting with an old but improved engine which met a requirement of the leading and best informed consulting electrical engineers, and for many years it had no rival. We are sure, however, that if the possibility of getting quietness and high-speed, without wear, in a double-acting engine by means of lubrication under pressure had been seen earlier the single-acting central valve engine would have had a very limited range.

In closing this correspondence as far as we are concerned, we would point out that we were drawn into it through the doubtful object of Messrs. Willans & Robinson's letter in a local paper, to the detriment of fellow competitors, on a practically undecided tender.

G. E. Belliss & Co., Limited.

Kindly allow me space for a short reply to Messrs. Willans. The point at issue, so far as I am concerned, is the false charge made by them that rope-driving is obsolete and inefficient.

That the first of these terms is false is amply proved by the continual repeat orders for that type of plant, and the fact that scores of makers of equal or better repute than Messrs. Willans are building and quoting for the same daily.

As regards the inefficiency, *they* admit the reliability of running (the chief point), and *I* have given working figures which surpass those of any direct driven station up to the publication of the 1892 accounts as given in *Lightning*. When Messrs. Willans have brought *their* working figures to the same level, I shall be pleased to join issue with them again. The latest figures of St. Pancras and Bristol are 30 per cent. behind mine. Westminster is better, but is due in my opinion to the engineer and the district rather than the engine. This, however, is not my point.

The respective merits of the two types I will leave to others to argue. What I have said on this point has been merely to justify my preference. The failures I mentioned in my first letter have never occurred to rope-driving plants, to my knowledge, but they have to direct-acting plants in past years, and until I get assurances to the contrary, not from the manufacturers or the consulting engineers, but from the station engineer in a quiet confidential chat, must consider their recurrence both possible and probable.

While willing to give Messrs. Willans full credit for their work in connection with central stations, I cannot allow them to make false statements against a type of plant with which I have beaten theirs, and trust they will be satisfied in future to push their own wares without trying to depreciate those of their competitors.

Ernest G. Pink.

We had not desired to write further upon this subject, which we considered settled for all practical purposes.

In our letter published last week, however, we spoke of the letter of your correspondent, Mr. Pink, as showing "that Mr. Hammond has disciples among those who have worked his stations." We are sorry to find from a communication from Mr. Pink that this statement has given offence. Mr. Pink, it appears, supports the views with which Mr. Hammond's name is commonly associated, and bases his support upon his experience at one of Mr. Hammond's stations. He denies, however, that he is a disciple of Mr. Hammond, and repudiates the suggestion with considerable warmth. We have pleasure in asking you to give currency to his denial. Mr. Pink adds that he has been an electrical engineer for 22 years, and for many years before he was introduced to Mr. Hammond.

Willans & Robinson, Limited.
C. S. Essex, *Secretary.*

Mr. E. G. Pink also writes us a letter in which he, as an electrical engineer of 22 years' experience, objects to find himself classed by Mr. Willans in "one of the leading technical journals of the day" as a "disciple" of one particular firm or person to whom he has been a successful adviser.

I have been much interested in the correspondence carried on in your valuable paper under the above headings, but up to the present moment I fail to see that any useful light has been thrown on the subject. No doubt, as Mr. Ruddle remarks in his letter of January 26th, "consulting engineers are divided in opinion as to the type of engines and mode of driving to be adopted in central stations," and I think it a pity that so far none of our leading consulting electrical engineers have thought it worth while to give us the pros

and cons which have led them to adopt one or the other system.

In your own leading article of February 9th, you say: "Rope-driving is resorted to for the purpose of getting up speed on the dynamo, but it is better to compromise and use a direct dynamo at less speed, coupled to an engine at a higher speed." Why compromise at all? By using the steam turbine you have a direct-driven dynamo running at a high speed at once. No doubt the high speed has kept many engineers from advising the use of such a combination, but, surely it has been proved by this time that the high speed does not militate in any way against this combination.

That engineers in charge of central stations could throw much light on the subject I have no doubt, for if they gave us the number of running hours of the engines in their charge, the amount of work performed by them, what I.H.P. they were built for, and the cost of repairs, &c.—say, for twelve months—it would be a step in the right direction. As for trials of engines in the makers' works, one must not attach too much importance to them. Everything, as a rule, is prepared and got ready to give the best possible results, and, after all, these trials rarely exceed 24 hours' duration; also, the engines are often running under very different results to what they are called upon to perform in practice. If it were possible to place the different types of engines used in central stations alongside one another, and run them all under the same condition for, say, six months, no doubt a fairly true result might be arrived at, but as this is impossible, I hope that the discussion will not be allowed to drop, but that those who are able to throw some light on the subject will do so.

George B. Garvey, M.E. and A.I.E.E.

LEGAL.

Carbold Oilless Bearing Company *v.* The Planet Company.

At the Westminster County Court on Monday, before his Honour, Judge Lumley Smith, Q.C., this case came on for hearing before a jury. The claim was for £12 17s. 4d. for 594 of Hedges's patent mica-foil fuses. There was a counter claim for £21 for breach of contract, and expenses incurred. Mr. Carrington and Mr. Cantley appeared for the plaintiffs, and Mr. Maddison for defendants. In opening the case at some length,

Mr. Cantley explained that the fuses were required for the Railway Clearing House at Euston, with whom the defendant company had a contract. There was a dispute pending between the railway and the defendants, and probably that accounted for the parties being in that Court to-day.

Mr. J. B. Rudkin, manager of the plaintiff company, stated that a few days prior to August 12th, 1892, Mr. Scott, manager of the defendant company, called upon him and asked the price of Hedges's patent mica-foil fuses. Witness handed him a card, on which he wrote the prices, and Mr. Scott went away. On August 12th he returned and handed witness an order for four sets, each consisting of 71 pairs of fuses, and he also handed in a specification. Witness explained that some of the sizes named for the eyelet holes were rather large, but Mr. Scott replied that they must be of that size, as their fittings were already made. The holes were all practically $\frac{3}{4}$ths of an inch, and nothing over $\frac{1}{2}$-inch. The next day witness made a sketch to instruct the workmen, and he then noticed that no particulars were given as to the width, and he then went to see Mr. Scott, and showed him the sketch. He entered into another room to consult his engineer, and on returning said the sketch would do very well. On August 16th four more sets were ordered, and they were delivered in two lots. The order was entirely completed by September 6th, and the invoice sent in. On September 7th witness received a letter from the defendants, in which complaint was made that some of the eyelet holes were smaller than the specification. Witness knew that he had made some smaller, and on receipt of that letter he sent other fuses. On September 10th he received a similar complaint as to some other fuses, and he attended to that. On October 26th, for the first time, he heard a complaint to the effect that the electrical engineer to the Clearing House stated that the fuses were not what they should be, and were not similar to those supplied to St. Pancras Station. On December 6th witness sent a letter to defendants asking for payment.

In reply to Mr. Maddison, Witness said Mr. Scott did not ask him which were the best sort of fuses to employ.

For the defence, Mr. Maddison said that what defendants ordered were fuses that would supply a particular current, and these that were supplied did not answer the purpose. Defendants had to go to the expense of putting other fuses in, and when they made complaint the plaintiffs said: "Oh, if you don't like to pay, we will put the matter into the hands of our solicitors." Fuses that were marked to carry up to 300 ampères went out before 150 was reached.

The Judge: Do you say that the low pressure fuses were useless, or only the high ones?

Mr. Maddison: Yes, we say the low pressure were useless.

Mr. Scott, secretary to the defendant company, was then called, also Mr. Shepherd, the electrical engineer to the defendant company.

In the course of his evidence, Mr. Shepherd gave details showing that £13 was spent by defendants in replacing some of the fuses, and £7 16s. expenses incurred in finding out the defects of the plaintiffs' fuses.

Mr. Langdon, engineer to the Railway Clearing House, said he complained that the high pressure fuses did not carry the current which was required. All those below 50 ampères had been passed by him; the others were removed. He did not call upon defendants to remove the whole of the fuses.

Mr. Maddison wanted to put in a letter written by the witness to the defendants, but Mr. Carrington objected, and his Honour ruled it inadmissible.

Mr. Killingworth Hedges was called for plaintiffs, and said that the way in which the fuses were put upon the bolts might make an immense difference. A fuse might be perfectly right, but if badly put on the bolt it might go at any current. On December 29th he went to the Clearing House and found all his fuses in use except five.

Counsel having addressed the Court, the Judge summed up.

The Jury, after an absence of about a quarter of an hour, found for the plaintiffs on the claim, and dismissed the counter claim.

His Honour entered judgment accordingly, with costs.

McCarthy *v.* The Electric Construction Company.

Before the Recorder (Sir Charles Hall, Q.C.) and a special jury last week in the Mayor's Court, this case was a claim by a former clerk of the Corporation, and the question was whether he was entitled to £2,237, the proceeds of 605 shares which the Corporation had sold. The defendant Corporation was founded in 1889 at the instance of the Building Securities Company, one of the notorious Balfour group. In June, 1889, 1,712 shares in the defendant Corporation were transferred to George Dibley, and they purported to be paid up. In 1891 Dibley transferred 1,500 of these shares to the secretary of the Building Securities Company for the consideration of £10. After the collapse of the Balfour companies 500 of these shares were transferred several times, but ultimately came into the defendants' hands, and were sold by them for £2,234, which the plaintiff claimed to be entitled to.

The defence was that the shares were transferred to the plaintiff as a trustee for the company.

Ultimately the jury stopped the case, and intimated that they were unanimous in favour of a verdict for the defendant Corporation.

India-Rubber, Gutta-Percha and Telegraph Works Company.

At Birmingham last week the above company were summoned for keeping at their Birmingham branch a solution which, within the meaning of the Act, was petroleum, without obtaining a license. Over 1,000 cans of liquid seized were found to contain a solution of rubber and naphtha, the proportion of naphtha being 84·3 per cent. The solution gave off vapour of 58 Fahrenheit, being less than 78, as required by the Act. It was argued, in defence, that the solution was not petroleum in the meaning of the Act, and that the Act was intended to apply to fine petroleum, and not to admixture with other substances for commercial purposes. It was extensively used in the manufacture of tyres and bicycles, and defendants were not aware that they were under any legal obligation. A fine of 40s. and costs was imposed, warning being given that future fines would be heavier.

This case is referred to at greater length on another page.

Muirhead *v.* Commercial Cable Company.

In the Queen's Bench Division of the High Court on Wednesday, the case of Muirhead *v.* Commercial Cable Company came before Mr. Justice Kennedy, sitting without a jury. This was an action to recover royalties from the defendant company under an agreement to use a certain patent belonging to the plaintiffs. In resisting the claim the defendants set up a defence calling in question the validity of the plaintiffs' patent for the Muirhead system of duplex telegraph for submarine cables.

Mr. Finlay, Q.C., Mr. Bousfield, Q.C., and Mr. Pollard appeared for the plaintiffs; Sir Richard Webster, Q.C., was counsel for the defendants.

Mr. Finlay, in opening, said the claim was for £1,899 due for the use of the patent from July to September, 1891; and £1,685 for the use of the patent from September to December, 1891.

The decision of the action would involve the question whether the plaintiffs were not to recover royalties from July, 1891, to November, 1897, being a sum of about £45,000. The defendants would contend that the patent in question had expired under the American law. Three of the plaintiffs were inventors of the system of duplex telegraphy, and they, on January 2nd, 1884, granted a license to the defendant company to use the patent. The defence involved an attack upon the patent, which, he should contend, was not open to a licensee to make.

The action is proceeding.

Edison-Bell Phonograph Corporation *v.* Young.

This case came before Mr. Justice Wright, sitting in the Queen's Bench Division, yesterday morning, upon a motion to commit the defendant, Mr. J. L. Young, to prison for contempt of Court.

Mr. Justice Wright, having heard counsel on both sides, dismissed the case without costs.

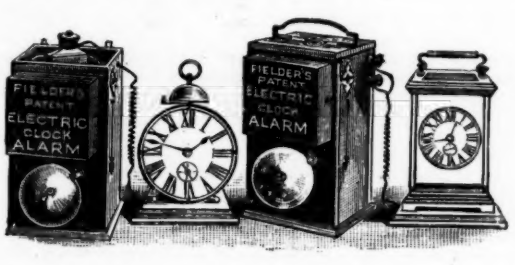
BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's) for 1894.—Published by H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. This directory comprises the names of 18,414 different individuals and firms, is divided into four sections, namely, British, Continental, American and Colonial, each of these being sub-divided into alphabetical and classified sections. There are about 800 pages consisting entirely of directory matter, making the book the fullest, as it is the oldest, electrical directory in the world. The price of the work is 4s., post free.

Taunton Electric Lighting.—The minutes of the Electric Lighting Committee contain the following paragraph regarding electric lighting operations at Taunton:—"The rough and wet weather of the past quarter has severely tried the installation of the overhead wires, but we have had no serious breakdown. We have fixed meters on all the larger consumers' mains, and are awaiting Dr. Fleming's report on the small meters to obtain and fix them. The new armature is running satisfactorily. The chief installations connected up during the past quarter are: Mr. A. Steevens, Osborne House, 52 16-C.P. lamps; Messrs. Pinchard & Alms, 10 16-C.P. lamps; club rooms, London Hotel, 14 16-C.P. lamps; Mr. Hallett's Phonographic Institute, 8 16-C.P. lamps; Mr. Crosse, East Street, 4 32-C.P. lamps, besides several old consumers having a few additional lights. We have had notice of about 30 more lights, and when our first sub-centre is in working order, and we have transformers relieved, we shall doubtless have many more applications for supply of current."

The Electric Lighting Committee have reported to the Town Council as follows:—"A letter has been received from Messrs. Newton offering to make a 30 kilowatt transformer, and to let the council have it on loan; also to make and send a second transformer to the same specification to Dr. Fleming to test, on the understanding that if it proves to be satisfactory the council will purchase both of them as soon as it is decided to start another sub-station, at the price quoted in their tender, dated November 2nd, 1893, viz., £183 each. The committee recommend that their offer be accepted, provided that they will guarantee that both transformers shall be identical, but that they would not be paid for the use of it as long as it was on loan. The committee ask the council to empower them (as the matter is urgent) to accept Messrs. Babcock & Wilcox's estimate for cross drains and the steam piping necessary to connect them with the engines and boilers at the electric lighting station, at the price of £170, subject to the approval of Dr. Fleming." This report was adopted.

Electric Clock Alarm.—We illustrate below an electric clock alarm which has quite recently been patented and is being placed upon the market by Mr. W. Fielder, of Herne Hill. The current does not in any way pass through the clock; the electrical portion can be used as an ordinary electric bell set, as the metal contact plate on the stand acts as a push. One of the chief features of the invention



is that the electric bell, which is started at any desired time by means of the clock, continues ringing until the person called gets out of bed to stop it. The clock and stand can, if desired, be in a separate room to that of the electric bell, in which case it is out of control of the servant or person awakened, and does not disturb the one who has control of the clock.

"Transmission of Power."—With this title a pamphlet has been published by the Westinghouse Electric Company, Limited. It is devoted to a description of the systems and apparatus furnished by them. The pamphlet has been prepared by Mr. L. B. Stilwell, of America. The opening remarks are general comments upon the various kinds of energy, and the methods of utilising them. Some tables and charts are given in a chapter dealing with distance and electromotive force. There are a number of other chapters, which are set apart for the following branches of the subject:—Insulation of apparatus for high potentials; Transformers; Direct current systems (this chapter also has tables and diagrams as well as a number of first-class process blocks to illustrate it); Development of high potential alternating systems; the Two-wire synchronous system; Efficiency; General information, which is very fully illustrated with diagrams, &c.; the Rotary transformer; Tesla polyphase motor, 5 H.P.; Ditto, 500 H.P.; Advantages of synchronous operation; Auxiliary apparatus and switchboard instruments; the Compensator; Overhead lines; Mechanical features of Westinghouse apparatus; Alternating current arc lamps. The matter is very interestingly written, and is more of a general treatise on the subject than a catalogue. Good paper has been used, and the printing and illustrations are of the first class.

Dissolution of Partnerships.—The partnership heretofore subsisting between Mr. Sheard Charlesworth and Mr. J. P. Hall as electrical and general engineers, at Richmond Hill Works, Oldham, under the style or firm of "Charlesworth, Hall & Co.," was dissolved as from 26th ult., and all debts due to, and owing by, the late firm will be received and paid by Mr. Hall, who has purchased Mr. Charlesworth's interest in the property and assets of the late partnership, and who is now carrying on the business of electrical and general engineer, under the style of "J. P. Hall & Co.," Blackriding Iron Works, Werneth, Oldham. Mr. S. Charlesworth is now carrying on business as an electrical and general engineer at the Richmond Hill Iron Works, Oldham, under the name of S. Charlesworth & Co.

Notice is also given that the partnership heretofore subsisting between Harris Ullathorne and John Alfred Edmondson, carrying on business as electrical engineers and contractors at Bradford, Leeds, and Huddersfield, under the style or firm of Ullathorne and Edmondson, has been dissolved as from the 24th February, and the whole of the assets of the partnership now vest in the said J. A. Edmondson, who will in future carry on the business alone in his own name, at the same addresses. All debts owing by and due to the partnership will be paid and received by Mr. Edmondson. Mr. Ullathorne has entered into partnership with Mr. Arnold Hartley, of Halifax. These two gentlemen will, in future, carry on the business of electrical engineers under the style of Ullathorne & Hartley, at 19A, Charles Street, Bradford.

Mill Lighting.—A very complete electric lighting installation has just been laid down at Eagley Mill, Bolton, for Messrs. Jas. Chadwick & Bro., Limited. A room has been set apart for the generating plant, and contains three 400 light dynamos of the improved "Tyne" two-pole type, made by Messrs. Ernest Scott and Co., of Newcastle-on-Tyne. The mill is wired for 800 16-C.P. lights. In addition to the plant already mentioned, another dynamo of the same make is placed in a different part of the mill and used for lighting the extensive offices. The office lighting consists of 140 16-C P. lamps. The whole of the installation work has been carried out by Messrs. Scott & Co.

The contract for lighting the new cotton spining mill of the Irwell Bank Spinning Company, Stoneclough, near Bolton, has been secured by Messrs. J. H. Parsons & Co, of Newcastle-on-Tyne. The contract comprises dynamos, switchboards, and fittings for 1,200 16-C.P.

A proposal is under consideration for the utilisation of the waters of the Aire for lighting Saltaire Mills by electricity.

Electric Lighting of a City Church.—On Friday last was re-opened in the presence of the Lord Mayor and Sheriffs, St. Mary-at-Hill Church, Eastcheap. Some very extensive alterations have been executed lately, among these being the wiring of the church for electric lighting. The latter part of the work has been carried out by Messrs. Smeeton & Page, the current being supplied from the mains of the City company. The total number of lights is 144, and these are distributed as follows:—The centre fitting, of excellent design, under the dome has 28 16-C.P. lamps; 6 12-light fittings of similar design are in the body of the church; 2—7 16-C.P. light standards are fixed at the Communion rail. The vestry, lobby, choir vestries, and the three entrances have 3 lights in each, the private vestry having 2 lights, and the organ loft and bellows room are also fitted. All the lamps are on double-pole circuits, and are controlled from one switchboard in the main entrance.

Tynemouth Borough Lighting.—A committee has reported to the Town Council that the borough surveyor had submitted to them a report of a sub-committee in reference to electric lighting in the borough. The sub-committee's report stated that Messrs. C. Parson & Co. had only tendered for the carrying out of such works as were necessary to retain the powers conferred by the provisional orders; that the tender of laying electric mains in Savill and Howards Streets, amounted to £1,355; for a dynamo which will carry an actual load of 700 C.P. lamps, £445: and for lighting the Town Hall buildings, £162, making a total of £1,962. The sub-committee recommended that application be made to the Local Government Board for sanction to borrow £2,000 to carry out the scheme, but that only £1,355 for electric cables be expended at present. After discussion the report was adopted.

Electric Lighting at Cardiff.—Mr. W. H. Massey last week reported to the Lighting Committee on the progress which had been made with regard to the electric lighting works. He said that 10,339 yards of pipes and cables had already been laid down, and in view of the accident which occurred to a horse at Bournemouth, they had at Cardiff adopted a system of laying pipes which included features he believed the Board of Trade would probably recommend for other places. Alderman Jacobs brought up the question of the employment of destructors for the purpose of generating electricity. Mr. Harpur, the borough engineer, said that in considering electric lighting they must not look upon destructors as an indispensable factor. The utilisation of destructors was entirely a secondary matter.

Mansion Lighting.—Messrs. Andrews & Preece, Limited, of Bradford, have secured the contract for the electric light installation for the handsome mansion now being erected at Ilkley by W. Smith, Esq. The motive power will be supplied by one of Messrs. Gilkes' vortex turbines. The specification has been prepared by, and the work is in charge of, Edwin Blakey, M.I E.E., consulting engineer, of Tanfield Chambers, Bradford.

Kingston Electric Lighting.—It is said that the Town Council are not altogether satisfied with the public lighting, and have lately been in communication with Messrs. Siemens on the matter.

Electric Lighting of Kensington Palace Gardens.—The electric lighting of Kensington Palace Gardens, for Sir Thomas Lucas, with 370 lights, which has been entrusted to Messrs. Drake and Gorham, is now practically finished. The solid construction of the building presented exceptional difficulties owing to the fact that Sir Thomas expressly stipulated that the building should not be interfered with in any way, so that no cutting away or making good was permitted, in addition to which the decorations are exceptionally fine, so that it was necessary to observe the greatest care throughout the whole work. The contractors have risen to the occasion and the result is in every way satisfactory.

Chelsea Town Hall and Electric Lighting.—The Vestry are arranging with Mr. Morgan Williams, engineer, to superintend the work of fitting up the Town Hall during its execution, for a fee of 25 guineas, also to examine and test the installation after completion for a fee of 15 guineas, further to inspect and certify its efficiency every 6 months, for a fee of 2½ guineas each. Thirteen estimates were received for wiring the buildings, these estimates varying from £225 to £250. Further questions require settlement before an estimate can be accepted.

Electric Light at Liverpool.—Messrs. Bennett & Druce, of Preston, have been entrusted by Messrs. Frisby, Dyke & Co., of Liverpool, with the complete lighting of their premises with electric light. The plant will consist of an "Otto" special electric lighting gas engine, giving 22-H P. on the brake, a special compound-wound dynamo, and about 250 lamps distributed over the shop and premises to the entire exclusion of gas. Provision is to be made for taking current from the supply company's mains in case a few lights are required during the daytime.

Maidstone and Electric Lighting. — The Electric Lighting Committee have reported as follows to the Town Council. Final decision has been delayed for a fortnight: "We have considered the schemes and proposals submitted to the board by various companies and private individuals for taking over the Maidstone electric lighting order, and we consider those of Messrs. Bourne and Grant are the most advantageous to the borough."

Catalogues, Lists, &c.—Messrs. Miller & Woods have brought out a very small priced catalogue of electrical specialities. The following are some of the articles described and illustrated:—Transformer for heating medical cauteries, Bradner single-cord counter weight, sub-divided transformer, pressure reducer for continuous current, lamp water-heater, medical battery box, focussing lamp.

The National Dental Hospital.—The electric lighting of the above has been carried out by Messrs. Roger Dawson, Limited, who are also supplying the Liverpool Dental Hospital with the same mechanical pendants as fixed here, which are arranged to throw the light in any direction. They are also installing the electric light into the Royal Ophthalmic Hospital.

Electric Cranes. — Following the completion of the electric cranes erected by Messrs. J. G. Statter & Co., Limited, for the Southampton Harbour Board, and those for the London and India Docks Joints Committee, the firm have received an order from the South Western Railway Company, of Russia, for three electric cranes and generating station for the Harbour of Odessa.

Croydon Electric Lighting.—At the last meeting of the Town Council a member moved that application be made to the Local Government Board for sanction to borrow £25,000 for electric lighting purposes. After a lengthened discussion the subject was referred back to a committee.

York and Electric Lighting.—A committee of the York Corporation, on Tuesday night, interviewed representatives from the firms who have tendered for the installation of the electric light and decided to consider as to the character of their recommendation to the council at their next meeting.

Windsor Electric Lighting.—Messrs. Roger Dawson and Company have been fined £2 and £1 costs, and 3d. for each square foot of roadway disturbed, for having broken up the paving and roadway in High Street in January without having first obtained permission.

Ashford and Electric Lighting.—It has been arranged that the grounds of the Trades and Inventions Exhibition, shortly to be held at Ashford, shall be illuminated by the electric light, and a contract has been entered into with Mr. King, of Maidstone, while Mr. Parker, of Rochester, is the consulting engineer.

Southwark Electric Lighting. — The St. Saviour's Board of Works will shortly be requiring the electric light for certain premises they have in course of erection, but the City of London Electric Lighting Company not being ready to supply in Southwark district yet, the board have decided to hurry them up.

Isle of Man Tramways.—The directors of the Isle of Man Tramway Company have submitted to the shareholders an offer for the purchase of their undertaking for £38,000. The offer is made by the Douglas and Laxey Electric Tramway Company.

Blackpool Tower Lighting.—With reference to our paragraph *re* "Electricity at the Blackpool Tower," we learn that the engines in question are Crossley's new type double cylinder.

Electric Fire Alarms.—The Acton Local Board are enquiring as to the probable cost of establishing a system of electric alarms and calls in the district.

CONTRACTS OPEN AND CLOSED.

OPEN.

Edinburgh.—March 17th. For the following work in connection with the electric lighting of the city for the Corporation—viz, contract No. 5, construction of concrete culverts, and laying of stoneware and iron pipes and casings; No. 6, supply of cast-iron pipes, casings, and road service boxes; No. 7, supply of stoneware casings and insulators; No. 8, supply of copper strip; No. 9, supply of armoured and unarmoured insulated cable. Copies of any of the specifications can be obtained on written application from Mr. Wm. Skinner, town clerk, City Chambers, Edinburgh. All information will be supplied by Prof. Alex. B. W. Kennedy, the consulting electrical engineer to the Corporation, 14, Old Queen Street, Westminster, London, S.W.

Harrogate.—March 14th. For the following plant in connection with the proposed electricity works, for the Corporation of Harrogate, a refuse sorting and drying plant, with accessories; steam boilers and accessories, steam and exhaust pipes, transformers and accessories, distribution mains. Specifications for all or any sections may be obtained on application to Mr. Samuel Stead, borough surveyor, Municipal Offices, Harrogate.

Sutton (Surrey).—April 4th. The Local Board invite tenders for the purchase of the powers granted in their electric lighting provisional order. For fuller details see our advertisement pages.

CLOSED.

Leeds.—The directors of the Yorkshire House-to-House Electricity Company, Limited, have decided to let the contracts for the extension of the electricity works as follows: To William Nicholson & Son, for the buildings; to Messrs. Hick, Hargreaves & Co., Limited, and Messrs. John Fowler & Co., Limited (Leeds), for the plant.

Norwich.—The tender of Messrs. A. Pank & Son, of Norwich, to provide and fix fittings for lighting by electricity the Guildhall, Municipal, and Sanitary Offices, for £290 17s., has been accepted conditionally.

FORTHCOMING EVENTS.

Friday, March 2nd.—Annual dinner of the National Telephone Company, Holborn Restaurant, 7.30.

Friday, March 2nd.—The Institution of Electrical Engineers. Students' meeting at 28, Victoria Street, S.W., 8 p.m. A paper will be read on "Lightning" by E. H. Bowyer, Esq.

Saturday, March 3rd.—Royal Institution. Lord Rayleigh on "Light, with Special Reference to the Optical Discoveries of Newton."

Tuesday, March 6th.—Institution of Civil Engineers. Ordinary meeting at 8. Papers to be further discussed: "The Liverpool Overhead Railway," by Messrs. J. H. Greathead and Francis Fox, and "The Electrical Equipment of the Liverpool Overhead Railway," by Thomas Parker.

Thursday, March 8th.—Institution of Electrical Engineers, at 8 p.m. Mr. W. M. Mordey. "A Note on Parallel Working through Long Lines."

Saturday, March 10th.—Lord Playfair, at the Mansion House, on "The Modern Needs of Scientific Teaching," before the students of the London Society for the Extension of University Teaching.

NOTES.

Personal.—It will doubtless surprise many of our readers to learn that two gentlemen well known in the electrical field have determined to sever the connections they have held so long in their respective avocations. We allude to Edwin J. Houston, Professor of Physical Geography and Natural Philosophy in the Central High School of Philadelphia, who has held this chair for the past 26 years, and who has just resigned; and Mr. A. E. Kennelly, who during the past six years has been Mr. Edison's right hand man and chief electrician, and who is about to leave Mr. Edison's laboratory. We are pleased to inform our readers that these gentlemen have decided to establish in Philadelphia a firm of electrical experts, to be known as Houston & Kennelly. It is not necessary to remind our readers that Prof. Houston is president and Mr. Kennelly one of the Vice-Presidents of the American Institute of Electrical Engineers. We wish them success in their new undertaking.

The Electrical Standards Committee.—A meeting of the Electrical Standards Committee was held at the Board of Trade last Friday, at which the following members were present:—Sir Courtenay Boyle (in the chair), Mr. F. J. Hopwood, Major Cardew, Lord Kelvin, Mr. W. H. Preece, Lord Rayleigh, Prof. G. Carey Foster, Mr. R. T. Glazebrook, Dr. John Hopkinson, Prof. W. E. Ayrton, and Sir T. W. P. Blomefield, secretary.

South African Telegraphs.—Mr. Rhodes is to meet some opposition regarding his overland telegraph line scheme. Intelligence has been received at Cape Town that the Portuguese officials, acting on instructions from Lisbon, threaten to oppose the construction of telegraph lines between the British spheres of influence and Tete, on the Zambesi. This is the route which it was intended should be followed by the sections of Mr. Rhodes's projected overland telegraph line, to connect Matabeleland to the South of Portuguese Zambesia with Nyassaland to the North.

The Diamond in the Electric Arc.—There are few who would care to subject their jewels to the action of the electric arc, if what Mr. Moissan says regarding their behaviour be true. In the *Comptes Rendus* he describes what happens when a diamond is placed within the arc. He says it becomes incandescent, swells up without melting, and becomes covered with black masses of crystalline graphite. When placed in his electric furnace the diamond splits up, under the influence of an arc produced by a current of 70 volts and 400 ampères, into small fragments along the lines of cleavage, swells, and then becomes completely converted into graphite. It follows that at the temperature of even a moderately intense electric arc the stable form of carbon (diamond being pure carbon) is graphite.

India-Rubber v. Gutta-Percha.—At the library of the Institution of Electrical Engineers is to be seen a report recently presented on the Yof-Sakar land cable repairs, 1893, by Mr. Charles Bright, Assoc.M.Inst.C.E., who was the engineer on behalf of the India-Rubber Company, of Silvertown, the owners of the line in question. The report is addressed to Mr. H. Benest, engineer-in-charge of the South American cable repairs, from which expedition Mr. Bright was specially detached. Originally laid in 1885, the lines were first repaired in 1886 by Mr. J. Schneider. They were again repaired, in 1889, by Mr. Mouret, and subsequently, in 1890, by Mr. Julien. Mr. Mouret died a short time after being engaged on the work, owing, it is considered—as in the case of Mr. Goodson, who laid the original lines—to the effect of malarial vapour given off by some neighbouring marshy ground. Mr. Bright has had a long experience of unhealthy climates, and the special precautions he took enabled him and his assistants to successfully accomplish his work without any serious illness. It is seldom that one meets with such a plain unvarnished statement of facts, pleasant and unpleasant alike, as the report contains. Much valuable information is given, particularly as to the behaviour of both gutta-percha and India-rubber when buried in a tropical soil, and exposed to wet and dry alternately. Parts of the original core seems to have decayed very quickly. It is described as being in a completely perished state, the gutta-percha gradually dropping off in a white chalky form. The whole line seems to have been in such a bad state, that it is very possible that a bare copper conductor would have proved just as efficient as the core. Even the India-rubber core put in on one repair, at a spot marshy at times and dry at others, where the gutta-percha core had rapidly decayed, behaved no better, for wherever the cable was opened out the India-rubber was found to be in a perfectly pulpy state, not unlike putty size. The unsatisfactory feature about the whole of the arduous work carried out by Mr. Bright is that through his being provided with the usual G.P. cored cable, his repairs, like the previous ones, cannot be regarded as anything but temporary. The remedy he suggests is the encasing of the core in lead or with a spiral brass tape; and one of these, provided great care is taken in the laying of the cables, would probably be effective, although lead will perish very rapidly in certain soils. The ground seems to be a peculiarly suitable one for experiments; but, unfortunately, there seems to be a considerable risk to the lives of those carrying them out.

Birmingham Electric Lighting.—The Market Hall is to be lighted electrically, and the City Council will borrow £1,000 for that purpose. The electric supply company offered special terms, with the result that the electric light will cost less than gas; 32 arc lamps will light the buildings, and eight others will be distributed outside.

Newcastle Electrical Property.—The various public undertakings of Newcastle-on-Tyne have lately been revalued. The electric supply company and the electric lighting company, which were previously returned at £787 and £504, are now valued at £820 and £972. A new concern (the National Telephone Company) is rated at £2,636 on a gross value of £3,166.

New Journal.—*Science Progress* is the name of a new monthly review of current Scientific Investigation, which was to be published on March 1st by the Scientific Press, 428, Strand. It will be edited by Prof. J. Bretland Farmer, with the assistance of an Editorial Committee, consisting of Prof. H. E. Armstrong, F.R.S.; Prof. C. S. Sherrington, F.R.S.; Prof. J. W. Judd, F.R.S.; Prof. R. T. Weldon, F.R.S.; Prof. G. B. Howes, F.Z.S.; and Prof. H. Marshall Ward, F.R.S. Amongst the contributors to the earlier numbers will be Profs. Armstrong, Burdon-Sanderson, Dunstan, Fitzgerald, Goebel, Halliburton, and Ray Lankester. Notices and reviews of all the effective work that is being accomplished in the various branches of science will be included.

Society of Engineers.—Mr. Geo. A. Goodwin, Wh. Sch., M.I.C.E., has been appointed president of this society. He delivered his presidential address on 12th ult. at Westminster, the subject being "The Present Position and Practice of Mechanical Engineering." He also touched upon marine engineering, railways, &c. Electricity was also dealt with, and reference was made to its various applications, including that for printing the daily and weekly papers when power was only required for short periods per day, saving initial outlay, space, attendants, and firing up losses. Suggestions were also made that electric light companies should sell current for power purposes at any time of day or night at a reduced charge. Electric cable and steam traction was then reviewed, as also the particulars of the systems and costs of working.

The Magnetisation of Soft Iron.—An important contribution to our knowledge of the magnetisation of soft iron was made by Mons. P. Joubin, at a meeting of the Paris Academy of Science, held on January 15th. He has deduced from Rowland's experimental results (*Phil. Mag.* [4] Vol. xlvi., p. 140), a characteristic equation which he states as follows:—

$$x = 1 + 0{\cdot}33\,(1 - y) \pm 1{\cdot}3\,\sqrt{1 - y},$$

where $$x = \frac{I}{I_c} \text{ and } y = \frac{K - K}{K_c - K_o},$$

I is the intensity of magnetisation, and K the susceptibility of the material, K_o the susceptibility when the field is *nil*, and I_c, K_c, critical values. Mons. Joubin's experimental results fully bear out his theoretical conclusions.

Mr. Wilson Hartnell and the Leeds Tramway.—Mr. Wilson Hartnell in a letter to the *Leeds Mercury* speaks eloquently of the electric tramway on the Roundhay Road, and compares it with the other methods of tramcar propulsion. He urges the Corporation to extend the system into Briggate, and points out that no difficulty would arise from the overhead wires. He concludes by saying that the Thomson-Houston Company have given us a new-world service. "Where is there in the British Isles such another? The men are smart, the cars are smart, and the service is smart. This company have given to us one good example of cheap and rapid transit, combined with the maximum comfort and convenience to passengers. I hope that large numbers of your readers, from the members of the Council downward, will take the experimental journeys above indicated, and calculate the aggregate days to be added to the life of the travelling community by the extension of the Roundhay tram service, and unite, as a first step, to bring the electric cars into the city."

Electric Light at Aberdeen.—Current was turned on last Tuesday by the Lord Provost's wife from the Town Hall balcony.

Kingswood Electric Tramway.—The Bristol Council last Tuesday assented to the tramway company's Bill for an electric overhead wire tramway from the city to St. George and Kingswood, three miles and a half, at an expenditure of nearly £50,000.

The British Association 1894 Meeting.—In our advertisement pages will be found a notice to contributors of memoirs for this year's gathering at Oxford. The meeting commences on Wednesday, August 8th, the president for the year being Lord Salisbury.

Electric Light at Edinburgh.—An electric lighting scheme has been adopted for Edinburgh, by which the whole city will be furnished with the new illuminant within five years. The capital expenditure will, it is estimated, be about £130,000. The annual cost of lighting the city by electricity will exceed the annual cost of lighting it by gas by about £2,000.

Accident at Worcester Lighting Station.—Some days ago one of the men employed at the electric lighting buildings at Powick, was reaching a lamp, when he fell off a wall into deep water below, and becoming caught in some of the scaffolding under the water, was in imminent danger of his life. Fortunately a fellow workman managed to catch hold of one of his legs, and thus saved him from a watery grave.

The Royal Society.—Before this society the following papers were down for reading yesterday afternoon:—"On the Effect of Magnetisation upon the Dimensions of Wires and Rings of Annealed Iron," by S. Bidwell, F.R.S. "On the Relations of the Secular Variation of the Magnetic Declination and Inclination at London, Cape of Good Hope St. Helena, and Ascension Island, as exhibited on the Magnetarium," by H. Wilde, F.R.S.

Electric Lighting at Friedrichsruhe. — Prince Bismarck is causing his castle at Friedrichsruhe to be lighted electrically, and has entrusted the Hamburg branch of the firm Schückert & Co. with the execution of the installation. For effecting the lighting a saw-mill at Sachsenwalde, belonging to the Prince, and situate at the distance of only a few minutes from the buildings to be illuminated, is to supply the necessary power.

Hermite's Electrical Sanitation Process.—On Tuesday we had an opportunity of inspecting a small model system projected for the supply of electrolysed sea water for sanitary purposes in towns. This experimental plant has been erected at Worthing, a town which at present is being thoroughly drained on modern sanitary principles. The plant is in the hands of Messrs. Paterson & Cooper, of London, and consists of an 1,800-watt dynamo working at 6 volts and 300 ampéres, with an "electrolyser" of similar capacity. The demonstration was successful so far as it went, and we shall treat the subject more fully in next week's issue. It is not decided yet as to what extent the process is to be adopted at Worthing: in all probability it will be employed for flushing the main drains only. The adoption of the system in its entirety is accompanied by some considerable expense for service pipes, &c., a house to which the system would be applied requiring two complete sets of water pipes, a fresh water set, and a sanitary set. Every information was courteously given by the inventor, who is a well-known specialist in electrolysis, but no data from which the power required for electrolysing, or the actual cost of the process in practice, could be estimated, was obtainable; and these, of course, are the main considerations, commercially speaking.

The Worthing Town Council has voted a sum not exceeding £200 to enable M. Hermite to demonstrate his scheme, and the British Institute of Preventive Medicine has deputed Sir Henry Roscoe and Dr. Ruffer, its president and secretary, to watch the proceedings on its behalf, and to make the needful chemical and bacteriological analyses.

Deep Sea Soundings.—The Admiralty List of Oceanic Depths received at the Hydrographic Office during last year is now published. The total number is 526. Of these 251 have been taken by Her Majesty's ships *Egeria*, *Penguin*, *Dart*, *Stork*, and *Marathon*, while of the remaining, 196 are by the telegraph steamers, *Silvertown* and *Dacia*, belonging to the India-Rubber, Gutta-Percha and Telegraph Works Company, Limited, and 79 by the West Coast of America Telegraph Company's ss. *Retriever*.

Lectures.—At Richmond Athenæum last week, Prof. Carlton Lambert delivered a lecture on "Modern Developments of Artificial Illumination." Electricity was dealt with at some length.

At the monthly meeting of the Leeds Association of Engineers held the other day, a paper was read by Mr. Chas. J. Hall on "The Generation and Distribution of Electricity."

On Tuesday last week Mr. Kirker, C.E., Surveyor to the Dromore West Board of Works, delivered a lecture in the Presbyterian Schoolhouse on "Electric Light."

NEW COMPANIES REGISTERED.

Electric Time-Distributing and Clock Company, Limited (40,525).—This company was registered on the 17th ult. with a capital of £5,000 in £1 shares to acquire the invention of E. Dubois, together with all British and foreign patent rights for his method of improvements in electric clocks, and to enter into an agreement for that purpose. The subscribers (with one share each) are:—D. Ramage, 47, Lancaster Road, Richmond, gentleman; E. Dubois, Avondale, Earlsmead Road, Tottenham, watchmaker; W. Aubert, Bank Buildings, Ludgate Circus, engineer; H. R. Termitte, 102, Sheen Road, Richmond, gentleman; S. R. Glyn, 48, Bedford Row, W.C., solicitor; S. J. Wilkinson, Haverstock Hill, clerk; F. G. Beaumont, Victoria Park, clerk. The number of directors is not to be less than three nor more than seven. Qualification, £100; remuneration not stated. W. Aubert is to be the managing director of the company. Registered by E. Kennedy, 57, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

General Electric Company, Limited.—This company's last annual return, filed on January 8th, shows that out of a nominal capital of £60,000, in 7,000 first preference, 1,000 second preference, and 4,000 ordinary shares, all of £5 each, 11,325 shares have been taken up, and that £5 has been called on each of 6,325. The total amount of calls received is £31,625, and £25,000 has been agreed to be considered as paid. From a document dated January 11th, 1894, it appears that the nominal capital of this company has been increased by the addition of £25,000 in £5 shares, beyond the registered capital of £60,000.

General Electric Power and Traction Company, Limited.—The annual return of this company, filed January 25th, 1894, shows that out of a nominal capital of £350,000, in 25,000 ordinary and 10,000 preference shares of £10 each, 23,592 ordinary and 10,000 preference shares have been taken up, and that the full amount has been called on 23,592 of the former class, and £9 on each of the latter. The total sum received is £107,985; £217,340 has been agreed to be considered as paid, and £595 is in arrear.

Italian Electrical Light and Power Company, Limited.—This company's annual return shows that out of a nominal capital of £60,000 in £4 shares, 307 shares have been taken up. Nothing has been called or paid, but £1,200 has been agreed to be considered as paid on 300 shares.

Pneumatic Patents Company, Limited.—This company's registered office is now at Dock House, Billiter Street, E.C.

BOOKS RECEIVED.

La Trazione Elettrica. By Ing. Guilio Martinez. Published by Ulrico, Hoepli, Milan.

CITY NOTES.

Kensington and Knightsbridge Company's Accounts.

We have received an encouraging letter from a valued correspondent, who takes exception to our analysis of the Kensington Company's accounts. Our only desire is to give as near as possible an accurate statement of affairs, and we must frankly admit that a serious error was made when we made the total costs 5d. per unit The mistake arose from our taking a sum of £2,000 from renewal account, which, as a matter of fact, was included in a larger sum shown in the revenue account. Our correspondent, at the same time, finds fault with us for including in the total costs the sum of £1,339 for miscellaneous and law expenses. No doubt the law expenses in this instance can be fairly considered abnormal, because they were consequent on the Lane-Fox and the three-wire cases. If this sum is left out, although there is nothing to show what miscellaneous covers, the total cost per unit comes out as our correspondent suggests—about 3·6d. It is not every lawsuit which can be fairly excluded from the costs' accounts, but it will be only fair to the Kensington Company to omit them in this case, in order to put them on a proper basis with some of the other supply companies. Our correspondent finds a good deal of fault with our methods of getting out costs; but is the Kensington Company's system of accounts all that is to be desired? We do not say this for the purpose of qualifying our apologies to the Kensington Company, nor our thanks to the correspondent who amiably corrects our blunders. After deducting various items, the total cost is 3·6d., and the Kensington Company may, if they please, accept our hearty, though tardy, congratulations upon the excellent result.

Newcastle-on-Tyne Electric Supply Company.

We have analysed this company's accounts, and find that the total cost per unit is 3·1d. It is, however, necessary to point out that we have been obliged to take the cost of supplying public and private lamps together. As, however, the supply to public lamps is not a large item, it makes no material difference in the total costs. When extensions of street lighting take place, we trust that the company will see the utility of keeping the accounts separate, as is done by the City of London Company. We have added the cost of attendance and repairs of street lamps on to the cost of repairs and maintenance, but have omitted altogether from the costs, repairs of apparatus on consumers' premises. We are pleased to note a considerable increase in the number of lamps connected.

	1891.	1892.	1893.
Total capital invested... ...	£34,352	£40,699	£45,715
Number of units sold	244,470	335,141	360,467
Number of lamps connected ...	12,314	15,954	18,150
Revenue from sale of current...	£4,328	£5,663	£6,161*
Net revenue	—	—	£2,549
Average price obtained per unit	4·22d.	4·05d.	4·08d

* Includes the sum of £216 for public lighting.

Cost of Production.	£	s.	d.	Per unit.
Coal	947	0	0	·63d
Oil, waste, water, and engine room stores	263	0	0	·17d.
Salaries and wages at generating station	1,162	0	0	·77d.
Repairs and maintenance of buildings, engines, boilers, dynamos, motors, &c.	680	0	0*	·79d.
Rents, rates and taxes	252	0	0	·16d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, stationery and printing, general establishment charges, auditors, law expenses and insurance	920	0	0	·6d.
Total				3·12d.
Revenue.				Average price obtained per unit.
By sale of current (including public lamps)	6,161	0	0	4·08d.
Sale of lamps and installation work	639	18	5	
Total	£6,800	18	5	4·08d.

* This item includes attendance and repairs on public lamps.

Liverpool Electric Supply Company.

There has been a slight increase in the working costs of this company, due no doubt to the increased costs of coal during the strike, and the increased cost of management, due to the new Lark Street station, which we expect is not yet working at its full capacity. The lamp connections have increased from 20,254 to 25,784. The balance to the credit of the profit and loss account, including £4,851 paid for interim dividend in September last, is £12,710. A dividend of 5 per cent. is to be paid, and £1,000 carried to reserve fund. We are glad to see that the chairman, at the annual meeting, a report of which appears in these columns, held out more or less sanguine hopes of being able to reduce the price per unit. The Highfield Station was overworked during last winter, and to meet the probable increased demand next winter, it has been decided to put in three new boilers. Extensions are also anticipated at the Oldham Street Station.

The analysis of the costs' account shows that the total cost per unit, exclusive of depreciation and renewals, is 2·73, against 2·43 for last year. This is due to the cost of coal having increased from 73d. to ·92d., and as we pointed out, there has been a slight increase in rent and management expenses. The station costs amount to 2·07, against 1·84 for the year 1892.

	1891.	1892.	1893.
Total capital invested	£162,641	£186,439	£214,222
Number of units sold	580,131	796,281	873,325
Number of lamps connected ...	—	20,0 0	25,000
Revenue from sale of current ...	£18,000	£23,200	£24,735
Net revenue	—	—	£9,589
Average price obtained per unit..	—	—	6·9d.

Cost of production.	£	s.	d.	Per unit.
Coal	3,369	0	0	·92d.
Oil, waste, water and engine room stores	594	0	0	·16d.
Salaries and wages at generating station	1,382	0	0	·35d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,335	0	0	·64d.
Rates and taxes	223	0	0	·06d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	2,186	0	0	·6d.
Depreciation of buildings and plant account	3,830	0	0	1·05d.
Renewal fund account	2,000	0	0	·54d.
Total				4·32d.

Revenue.				Average price obtained per unit.
By sale of current	24,735	0	0	
Meter Rents	948	0	0	6·9d.
Sale of Lamps	1,121	0	0	
Total	£26,804	0	0	6·9d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·73d.; works cost, 2·07d.

Yorkshire House-to-House Electricity Company, Limited.

We are pleased to publish the following letter from Mr. Green, the secretary of the Yorkshire House-to-House Company:—"I take this opportunity of making the following remarks upon your appreciative paragraph in last week's issue:—The figure of 130,068 units *sold* (not generated) is for the entire period of 12 months. I may remind you that in December, 1892, a supply was commenced, a semi-portable engine being hired for the purpose, and this temporary plant was in use up to the starting of the permanent machinery. The accounts now issued show the transactions for the whole year, and show a slightly greater cost per unit than has been incurred on the production since May 1st, as the cost of working the small temporary plant was, of course, comparatively high. The number of units sold prior to May 1st is estimated at 6,828, which just covered expenses. With regard to your treatment of £240 paid for interest on loan, I may inform you that the loan of £6,000 was raised on land, of which only about a third is used for our present works, and part of the surplus property is let off. The revenue from this source, you will see, amounted last year to £142 0s. 3d., and I do not think you will consider that more than the balance (£97 19s. 9d.) ought to be charged in the cost as rent. You will also notice that this interest, like the rents receivable, is for the entire 12 months."

The word generated was used inadvertently for "sold," but of course this does not affect the results. We quite agree with Mr. Green that the sum of £142 should be deducted from the interest payable on loan, and we have done this; the total cost is not seriously affected, but to be accurate, we will give the cost, which is now 5·1d., instead of 5·4d. given last week.

Bath and Cambridge Companies.

We have received copies of the Bath Electric Light Company and Cambridge Electric Light Companies' accounts, which we hope to notice next week.

The Notting Hill Electric Lighting Company, Limited.

The annual meeting of shareholders of the above-named company was held on Tuesday last, at the central station, Bulmer Place, High Street, Notting Hill Gate, Prof. William Crookes (chairman of the directors), presiding.

Mr. R. G. Rawkins (the secretary) read the notice convening the meeting, and the report and accounts were taken as read.

The Chairman, in moving the adoption of the report, before referring to other matters, congratulated them on the success of the working during the year. The result achieved had quite come up to their expectations. In the accounts there were one or two items about which a few words of explanation and comment might not be unnecessary. "No. 2 Loan.—Capital.—According to this statement the company is free from any mortgage or debenture debt, and the whole of its freehold and other properties are uncharged. In fact our only debts amount to £926 19s. 3d., and consist of certain monies advanced by consumers to pay for small extensions of mains which the company has agreed to allow to be taken out in current, thus preventing any risk being incurred by the company undertaking speculative extensions. In Capital Account No. 3, the item of £744 10s. appears against mains. This has been spent during the past year making small extensions to connect up houses requiring the light, and in most cases a satisfactory return on the capital outlay has been guaranteed. The expenses incurred by the losing side for costs and license were necessarily heavy, and were agreed to be divided rateably between the defending companies. The £522 11s. 11d. represent the proportion which we had to pay. For this we have a license to use the three-wire system through the whole of our area. It is estimated that the extra cost of construction, had this system not been adopted, would have amounted to between £5,000 and £6,000. No. 4. —Revenue Account.—Coal:—The cost of coal during the past year is seen to be identical with that of the previous year. The amount burnt, however, has been larger, and the revenue from the sale of current is about £1,000 more than before. This is due to various causes. Notwithstanding the protracted coal strike, the price paid was 3s. per ton less than that paid in 1892. On the first rumours of a strike, in consequence of the energy and foresight of our manager, Mr. Schultz, sufficient stock was laid in to carry us over any time of anxiety. Had this not been done, the company might have been seriously affected. Consumption of coal has also been saved by various alterations in machinery. The engines were not worked up to their full power in 1892. Indeed, we have not yet got them working to their full load, and it may therefore be estimated that next year the increase of revenue from current will be still larger in proportion than the expenditure for coal. Engineer and manager.—The directors have decided, in order to keep the fixed charges on as low a basis as possible, not to increase the engineer's salary, which is only £250 per annum, but, in order to remunerate him more in accordance with the market value of his services, have decided to pay him every year 5 per cent. on the amount of money distributed in dividend. I need hardly say that that will give Mr. Schultz a greater interest in the success of our undertaking, and at the same time will help to reduce the dead weight of fixed charges. Rates and taxes.—The directors would call attention to the enormous amount of rates and taxes, which come to £225 15s. 11d., mainly caused by the very high valuations put upon the company's works and mains. The directors consider that the valuation of machinery used in the earning business should be fixed at a reasonable rate, and not at such an amount as would bring the rates and taxes up to 3s. in the pound on the net revenue of the company. Householders live in houses where the rent is one-tenth of their income, and on the same basis the total rateable value of the buildings and machinery, &c., of the company should not be fixed at more than the tenth of its gross income. Rents payable.—This item will drop out in future accounts. Directors' remuneration.—The directors, who have already on former occasions proved their willingness to help the company by concessions in respect to their fees, again do not propose to draw the full amount they are entitled to, viz., £1,000 per annum, until the company can properly bear it, but in order to enable the company to start the new year free from all liability, they have agreed to take £440 in full discharge of fees due to them, amounting altogether to £2,123. Law Expenses.—The directors call attention to the fact that the law expenses last year were only £13 13s. As all questions of forms, agreements, and technical matters had been settled during the first two years of the company's formation, it was possible to make great economies on this item. You will see that the profit on last year's working amounts to £1,481 7s. 1d., a sum which compares most favourably with that of the previous year, when a loss of £137 would have resulted but for a fee of £250 from the New Telephone Company. The year before the actual loss was £554 18s. 6d. The balance of profit appearing in the net revenue account, after writing off the loss of £347 16s. 4d. brought forward from the last account, and allowing for a small amount of interest, amounts to £1,081 16s. 1d. Out of this balance the directors recommend the payment of a full dividend on the preference shares to December 31st last. I must say I am extremely pleased to have the opportunity of proposing the payment of the company's first dividend. The proportion of increase of revenue is about 10 per cent. less than the increase in the number of lights. Basing an estimate on the exact number of lamps on our mains December 31st, 1893, and without allowing for any increase whatever during the whole of 1894, a careful estimate shows a net revenue of £2,500, a sum which will enable about 2½ per cent. to be paid on our ordinary shares at our next annual meeting. Any increase in the number of lamps, or in their productiveness (and it is hardly necessary to mention that further applications have been received since the turn of the year) would be an addition to this revenue.—No. 6. Depreciation Fund.—The directors have not passed any money to this account, but they have expended out of revenue, and charged against the year's expenses, sums amounting to £617 5s. 6d., equal to about 1 per cent. dividend on the ordinary shares, in the way of renewals and re-construction. The directors did not consider that it was a proper thing to put this amount to capital expenditure, and then write off, say, 1 per cent. on the capital for depreciation fund account; it would have had the same effect, but would have unduly augmented the capital account. The whole of this work has been carried out by our own efficient staff, under the engineer's supervision, and the cost has been considerably less than would have been paid had others been called in to do the work. All our work is now concentrated under one roof, and the expenses all round have been reduced to the lowest point consistent with thorough efficiency. The savings will be more apparent during the current year. The mains and machinery have done their work well during 1893, no accident of any kind having occurred, except the flooding of a small part of the culverts with water on two occasions in January, owing to a fire-plug being blown out, causing a loss of about 250 units. It is gratifying to note that the London County Council, probably in consequence of the representations made to them by this company, have replaced the whole of the old-fashioned plugs at a considerable expense, and up to the present with satisfactory results, as no case of the kind has occurred so far during the present winter. As you see by the report, the mains at the present time run past or opposite to 980 houses which are not yet taking a supply of current. The number of lamps on our mains have increased by 2,715 during the year. This must be considered satisfactory, although the previous year's increase was 3,382. A large number of these were from the Phillimore extension. The average lamp earnings for the year still show a tendency to sink, being only about 6s. 6d. per lamp. This can be partially accounted for by the exceptionable bright weather during the last quarter of the year, and the almost total absence of fog, the majority of our customers having consumed less than for the corresponding period of the previous year. Another fact showing that the bright weather was responsible for the reduced consumption is that although the number of lamps during the last quarter was about 25 per cent. more than the previous year, the corresponding increase in current consumed was only about 15 per cent. The company's sheer cost per unit is lower than that shown in accounts published in 1893 of any other London company. This is all the more remarkable, inasmuch as our output is the smallest. At very little additional cost we could supply considerably more current, thus still more reducing the cost per unit. In conclusion, I can assure you that we shall continue to do our best in the interests of the shareholders. But the fact that we hold over £16,500 of the capital in our own names is, I think, a sufficient guarantee of this, and now we have turned, and more than turned, the corner, you will agree with me that the future success of our company is assured. I now beg formally to propose:—"That the report of the directors and the accounts to December 31st, 1893, submitted to this meeting, be and at the same time are hereby approved and adopted, and that a full dividend to December 31st, 1893, on the preference shares, be and is hereby declared, payable forthwith."

Mr. Alexander Howden seconded the motion for the adoption of the report.

The adoption of the report was carried unanimously.

The retiring directors, Messrs. Alexander Howden and J. T. Jervis, were re-elected. Messrs. Fox, Sissons & Co. were elected auditors, their remuneration to be 30 guineas.

The Liverpool Electric Supply Company.

The eleventh annual meeting was held last Friday at the Saleroom, Exchange Station Buildings, Liverpool. Mr. Arthur Hill Holme presided.

The Chairman, in moving the adoption of the report and accounts, said it afforded him great pleasure to state that the business of the company had been satisfactory during the past year, and they were enabled to offer a good dividend. Two things they had had to face were the coal strike and the exceptionally fine weather in the autumn, the latter fact tending to prevent the light being used as usual. The proposed extension of boundaries had also affected the company to a certain extent, but satisfactory arrangements with the corporation had been made. They had kept their contract with the public to give a good and efficient light. They had had fewer complaints than ever before, and he thought they might now say that the electric light throughout the city was as much to be relied upon as gas. In common with that much abused body—the gas company—they had been accused of charging exorbitant prices for light. Well, the balance-sheet would show that the dividend they paid was not exorbitant, and as a matter of fact, they had considerably reduced their price to customers. In 1891, the first year of operations, they supplied 580,000 units of electricity, at a cost of £18,030, while last year the supply was 885,000 units, and the cost £25,000. If they had maintained the price charged in 1891, the cost would have been £27,000, so that they had saved over £2,000 to their customers. There had also been a saving in the cost of lamps, and customers now got a better lamp at a lower cost. In the present year this would mean a saving of something like £1,500 to the customers, so that it would be seen the directors were not losing sight of economy while also looking after the dividend. The use of the electric light was increasing, and last year showed an increase of 26 per cent. in the number of lights used. It was absolutely necessary that they should increase their premises. They had acquired some property in Highfield Street, and tenants had received notices to quit. It was intended

to put down there three more boilers, in order to meet the demand for electricity, and also two more boilers at Oldham Place. The increase in the use of the light was satisfactory, and the time was rapidly approaching when every shop in the principal streets would employ it. The rulers of the city had not yet seen their way to use it, but no doubt they would in the future. In conclusion, Mr. Holme mentioned that about £29,000 would be spent on the proposed additions to the premises and plant, and they had given notice calling up the remaining 10s. on the shares.

Sir David Radcliffe seconded the motion.

The Chairman, in answer to Mr. Lister, said that the time in which the corporation could take over the company had been extended to 42 years, to date from the actual extension of the boundaries.

The motion having been carried, the dividend was declared at the rate of 5 per cent. per annum.

Mr. J. Lister, in moving that the directors receive 750 guineas as remuneration for their services, said that excepting the gas company, with which he was connected, he knew no body of men more useful to a great town.

Mr. John Given seconded the motion, which was carried.

Messrs. Samuel H. Holme and J. C. Vandrey were re-elected directors. Mr. W. L. Jackson was re-appointed auditor, after which the meeting closed with a vote of thanks to the chairman.

Telegraph Construction and Maintenance Company, Limited.

The thirtieth ordinary general meeting of the members of this company was held last Tuesday at the offices, 38, Old Broad Street, under the presidency of Admiral Sir G. H. Richards, K.C.B., F.R.S.

Mr. E. Dickens (secretary) read the notice convening the meeting, and the report and accounts were taken as read.

The Chairman proposed: "That the report and accounts of the directors to December 31st, 1893, submitted to the meeting be and are hereby received and adopted, and that a dividend of 36s. per share, in addition to 12s. per share interim dividend paid to June 30th, 1893, be paid on all shares of the company for the year ended December 31st, 1893, and that such dividend be paid free of income tax." The Chairman said he should like to mention particularly three things which during the year had happened closely concerning the company, although those events could not possibly affect their present position, and were not likely to affect their future position. They were mentioned in the report, but still the shareholders would scarcely expect him to pass them by without some remarks. The first event was a melancholy one. It was that of the death of their late chairman, Sir George Elliot, who was one of the first directors of the company, and had always been deeply interested in its affairs, and most keenly alive to its success. With reference to the second matter, viz., that of his (the speaker's) own position as successor to the late chairman, his colleagues were of opinion that his long connection with the management of the company probably rendered him one of the most fit persons to represent the shareholders' interests as their chairman; and as it was their unanimous wish, and as he felt it was also the wish of the chief officers of the staff, he could only accept the honour which was offered him. He trusted that the anticipations respecting him would be fulfilled. The third point he desired to allude to was the death of Captain Halpin, an officer who had served the company faithfully for 30 years. Captain Halpin was the captain of the *Great Eastern* for many years. He had commanded many of the company's ships, and had latterly been their marine superintendent. No doubt he was one of the pioneers of cable laying, and his great zeal and skill, and knowledge of telegraphic engineering, had enabled him to do good service to the company for many years. All connected with the company who knew him greatly regretted his death. With reference to the past year's work of the company, the chairman said that they had done a very fair year's work both in regard to cable manufacture and laying as well as in their general business. They had laid in various parts of the world cables covering a distance of nearly 4,000 miles very successfully. That really was the gist of all he had to tell them, so it was unnecessary for him to allude to any of the causes which had produced the commercial depression in almost every department of trade.

Mr. Phillip Rawson, J.P., seconded the motion for the adoption of the report.

After some discussion the report was adopted, and the directors and auditors having been re-elected, votes of thanks to the chairman, board, and staff was passed.

Waterloo and City Railway Company.

The first ordinary meeting of this company was held on Thursday last week, at the offices, Waterloo Station, under the presidency of Mr. Wyndham Spencer Portal, who said that the number of shareholders on the register was 38. His first duty was to lay on the table the Act of Incorporation empowering the company to construct an underground railway from Waterloo to the Mansion House. This being the first meeting there were no accounts to be submitted, but he might mention that everything was in trim for the operations of the future. As he had stated at the half-yearly meeting of the London and South-Western Railway Company, that company was deeply interested in the undertaking, which they regarded as of great value to them. It was to be a line for passengers only. It was estimated that it would be completed within 2½ years, as they anticipated no serious difficulty. In conclusion, he congratulated Mr. Scotter as the author of the scheme, as the South-Western Company had been wishing for such a line for the past 30 years.

The following gentlemen were then unanimously re-elected directors:—Mr. Wyndham Spencer Portal, Lieut.-Col. the Hon. H. W. Campbell, Major-Gen. Charles Du Plat Taylor, C.B., Mr. A. F. Govett, Mr. A. E. Guest, Mr. P. Mortimer, Mr. Charles Scotter, and Sir Algernon West, K.C.B.

Resolutions were afterwards adopted expressing concurrence in the issue of share capital to the amount of £500,000, with the usual borrowing powers, and in an agreement with the London and South-Western Company for the working and maintenance of the line, and for the guarantee by that company of interest on the capital at the rate of 3 per cent. in perpetuity, and for two-thirds of any surplus earnings after payment of that amount, the remaining third to go to the working company.

The Northampton Electric Light and Power Company.

The annual meeting of shareholders was held on Thursday last week, Mr. Seckham in the chair. The fifth annual report and accounts were presented and unanimously adopted, and the position and prospects of the company were discussed by the members present, and generally regarded as satisfactory. The following is the report:—

"The progress made by the company's undertaking during the year 1893, if not as rapid as could have been desired, has yet been steady and continuous. The lamps fixed are 4,600, as against 4,000 (at 8-C.P. each) at the end of 1892. The net revenue is £536 1s. 1d., as against £308 19s. 1d. Little inconvenience, if any, was occasioned by the coal strike, the company having entered into favourable contracts, and having the advantage of the sheds mentioned in the last report, for storage purposes. The directors were lately enabled to announce a reduction in the price of current, from 9d. per unit to 8d. (less 5 per cent. discount), to take effect from Christmas last, and they hope to be in a position to make a further reduction before long, to the mutual advantage of the company and its customers. The accounts will show that the income earned during the year was sufficient to provide for the debenture interest, and also to reduce to a very small amount the deficiency brought forward from the previous year. The directors who retire in rotation are Messrs. F. H. Thornton and H. E. Randall, and they are proposed for re-election."

City of London Electric Lighting Company, Limited.—In accordance with the intention of the directors, to which they gave expression at the meeting last Thursday week, a prospectus has been issued, inviting applications for a new issue of £100,000 5 per cent. debenture stock. The price of the stock will be £115 per cent., redeemable by the company at £125 per cent. after December 31st, 1910. The present issue is a part of the total issue of £400,000. The money is required to enable the company to push on with the electric lighting work in the City. The company has arrived at a stage when money that is put into the concern will materially add to the company's power for earning the larger revenue that is expected for the present year. The money, we understand, will not be lying idle, but will at once commence earning profits far in excess of the 5 per cent. interest that has to be paid on the stock. Complete details of the prospectus and the position of the company will be found in our advertisement pages. The list opens to-day, March 2nd, at 10 a.m., and closes at 4 p.m. *on the same day.*

The dividend warrants on all the preference shares of this company were posted to the shareholders on Thursday last week.

Morecambe Electric Light Company.—The report of this company for the year ending December 31st last states that the gross profit, £189 14s. 5d., is reduced by £92 2s., for interest on borrowed capital, and bad debts, £9 3s., leaving a balance of £88 9s. 5d., which the directors recommend to be applied to the payment of a dividend of 2 per cent. per annum on the paid up share capital. A fire at the company's premises involved a loss of £45, and the delayed delivery of a large engine involved a farther loss of about £120. The extension of service to Sandylands district is in rapid progress, and steady application for the light continues from all parts of the town.

The Direct Spanish Telegraph Company, Limited.—The board have decided, subject to audit, to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 4 per cent. per annum, free of income tax, on the ordinary shares, both for the half-year ended December 31st last.

Electro-Chemical Company, Limited.—Letters of allotment were posted on Tuesday, 27th ult.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 25th, 1894, amounted to £945; week ending February 26th, 1893, £943; increase £2; total receipts for half-year, 1894, £7,610; corresponding period, 1893, £7,743; decrease, £133.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,181.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 21st.	Closing Quotation. February 28th.	Business done during week ended February 28th. Highest.	Lowest.
184,500/	African Direct Teleg, Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640/	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	42 — 44	...	...
2,932,680/	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s	£5 2s	78½—79¼	79 — 80	79½	77
2,932,680/	Do. do. Defd.	Stock	...	...	...	7 — 7½	7 — 7½	7⅞	7 1/16
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11½— 12	11½— 12	11 15/16	11⅝
18,700/	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	..	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	135 —145	135 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13 xd	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18 — 19 xd	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	...	2 — 3	2 — 3	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9½	8 — 9	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10⅜— 10⅝	10⅜— 10⅝	10⅝	10⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	..	14⅛— 15⅛	14⅛— 15⅛	15⅛	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15⅞— 16⅛	15⅞— 16⅛	16⅛	15¾
105,900/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109	106 —109	...	...
1,294,100/	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	116¼	114½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	15⅜—15⅝	15⅜— 15⅝	15⅝	15⅜
62,700/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	102 —105	102 —105	...	...
222,800/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	102 —105	102 —105	104¼	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —117	115½	115
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	102 —105	102 —105	103½	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	102 —105	102 —105	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	102 —105	103 —106	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	109	108
180,227	Globe Telegraph and Trust, Ltd.	10	5½% §	4½% §	4⅝% §	8½— 8¾	8½— 8¾	8⅝	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅜	15⅛— 15⅜	15⅜	15⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8¾% §	8¾% §	...	21 — 22	20½— 21½	21	20⅝
200,000/	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	42 — 45	42 — 45	44¾	44
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	107 —110	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	2 — 3	2 — 3	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4½— 4¾	4½— 4¾	4¾	4½
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	15⅜	15⅛
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14 5/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5¼— 5½	5¼— 5½	5½	5¼
925,017/	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	113 —115	113 —115	114¾	114
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid ...	10	...	..	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid ...	1	2¼%	3⅜%	...	¼— ⅜	¼— ⅜	...	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	113 —118	113 —118	118	114½
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370/	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900/	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	102	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 2½	2 — 2½	...	...
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	97 —101	97 —101	97½	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	6½— 7	7 — 7½	7⅛	6⅞
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5½— 6	5½— 6	5 13/16	...
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	1⅞— 2⅛	1⅞— 2⅛	1⅞	...
178,200/	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	104 —107	104 —107	...	...
222,700/	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1½— 1⅝	1½— 1⅝	1½	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	9⅞— 10¼	9⅞— 10¼	10⅛	10 1/16
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	8½— 9½	8½— 9½	...	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	105 —108	105 —108	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	113 —118	113 —118	...	...
169,000/	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —105	103 —106	105	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5	4 — 5 xd	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	10 — 11	10½— 11½	11⅜	10⅜
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	12⅜— 13¼	12⅜— 13¼xd	13⅜	13
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5½— 5⅝	5 7/16— 5 9/16xd	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	...	6⅞— 6⅞	6⅞— 6⅞xd	6 7/16	6¼
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	...	8 — 8½	8 — 8½	8½	...
100,000/	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	104 - 108	106 —109	108	107
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4¼— 5½	4¼— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8¼%	7¼%	4¼%	6¼— 7	6¼— 6⅝	6 7/16	6¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8½	8 7/16	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3¼%	4 %	5⅜— 6¼	5½— 6 xd	6 1/16	6

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 21st.	Closing Quotation, February 28th.	Business done during week ended Feb. 28th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅝ — 2⅞	2⅝ — 2⅞xd	2¹⁵/₁₆	2⅝
90,000	Do. do. Non-cum. 6 % Pref, 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2⅜	2¼ — 2⅜xd	2⅜	...
125,000*l*	Do. do. 4½ % Deb.	Stock	...	...	...	105 — 107	104 — 107 xd	107	...
630,000*l*	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32xd	27 — 32	28	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 4	3 — 4	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ⅜	¼ — ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1⅛ — 2	1⅛ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	1/16 — ⅛	1/16 — ⅛	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	7/16 — 11/16	7/16 — 11/16	5/8	9/16
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅛ — ¼	⅛ — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1⅛	½ — 1⅛	...	...
12,134*l*	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	24 — 25	23 — 24 xd	24¼	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	103 —106	104¼	103
11,334	International Okonite, Ltd., Ord, 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	..	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	5¼ — 5½xd	5¼ — 5½	5 3/32	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	9 — 9½xd	9 — 9½	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	39 — 41 xd	41⅞	39⅜
150,000*l*	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅞.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅛—6⅜.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4⅛—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Some Notes on the Electric Lighting of the City of London.

(Read by Major-General Webber on February 8th, 1894.)

(Continued from page 227.)

The figs. 13 to 17 show the structure and the conditions of housing the transformers and switchboards and connections. Under such circumstances every inch was important, and it was to the suggestion of my chief assistant, Mr. Nisbett, that the plan of placing the transformers, F, below the floor was adopted in that station Height was the most elastic dimension, and it will be seen that the attendant standing over the transformers on a stage, C, has sufficient headway to stand up and attend to the board, S, one on the north, another on the south side.

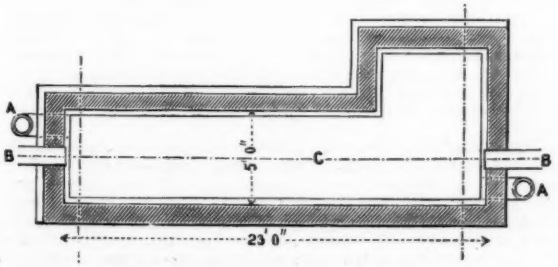


Fig. 13.—Plan at Level of Staging.

The floor of this stage is made of wooden squares, each of which can be taken off independently, and the top end of the transformer underneath exposed. When required to be removed, it is lifted by tackle suspended to a ring (as at W) in the arched roof, and, being received on to a hand truck, it is moved along the floor to the bottom of the entrance shaft, and there, by other tackle, carried by a tripod standing above on the dwarf walls, lifted up to the surface, where it can be lowered on to a suitable trolley and taken away.

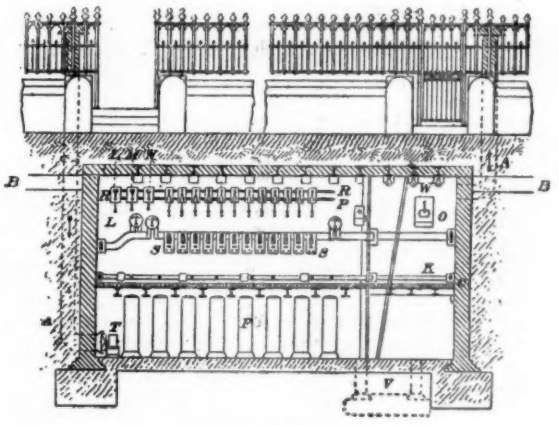


Fig. 14.

B shows where the conduits enter the station at the east and west ends.
D is the entrance for access to the descent by ladder into the staging.
F indicates the 18-kilowatt transformers.
G, the position of the primary 'bus bars on each side.
H, the main primary switches.
K, the low tension middle bar which runs round the tension.
L and N are switches for connecting at high tension with other transforming stations.
M, a switch to divide the station in two for repairs.
O, a recording voltmeter.
P, the telephone to the generating station.
R, one pole of high tension bar, with a switch to every two transformers, and Brush-Mordey fuses.
S, low tension switches on 'bus bar, with a switch to every two transformers, and separate fuses.
T, motor and fan for ventilation.

Drainage by a sump, V, and ventilation by large upcast and downcast shafts, A, A, are provided, as well as means of telephonic communication, P. The cost of the builder's part of the structure, when completed, is about £430, with an annual charge for the way-leave of about £5.

The honeycomb space under the staging floor should be able to receive 45 10-kilowatt transformers, of which 40 may be assumed to be in full use, the rest spare. The cost may be considered in the following way:—

	£
The present value of £5 a year for 21 years, at 5 per cent	64
Cost of building construction	430
" transformers and fittings, as per contract ... 400 kilowatts, at £7 per kilowatt	2,800
Add 5 per cent. for supervision and contingencies ...	182
Total cost of a transforming station (having a *maximum* space for 450 kilowatts)	£3,476

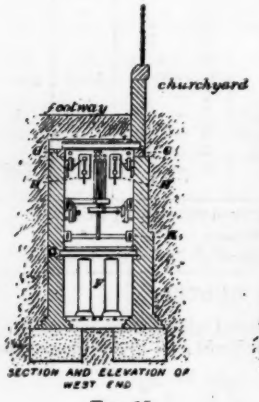


Fig. 15.

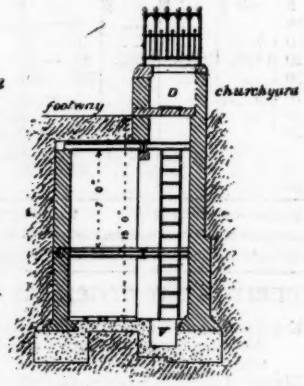


Fig. 16.

To arrive at the capital of cost of the plant between the generating station and the low pressure feeders, it is necessary to add the cost of two concentric mains; and this I have taken from a table that I prepared, which enables me to appropriate with very fair accuracy between the conduits for various purposes the cost of the underground work.

In this case the distance is about 1,200 yards.

Carried down	£3,476
Two 2½-inch wrought-iron conduits, at 4s. 4d. per yard	520
Two 0·154-inch concentric high insulation cables drawn in and connected	1,200-yard 1,150
These figures give a total capital outlay of	£5,146,

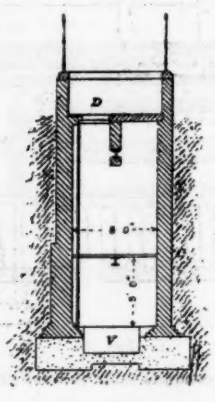


Fig. 17.

which will be repaid, interest and principal, at 4 per cent. in 21 years by, per annum, £161; to which should be added at least 2½ per cent. depreciation and repairs—say, £136—and £70 for attendance and small stores; total, £367.

Again, assuming a total consumption of about 18 units per 33-watt lamp fixed, and 12s. the gross earnings per lamp per annum, and allowing 96 per cent. efficiency as before, and the equivalent of 15,000 8-C.P. lamps connected with this one station, or, say, £9,000 per annum, the above annual charge will represent 4 per cent., being a standing charge on every unit sold.*

* A useful comparison may be drawn between the cost of these 2,000-volt mains and low tension mains at 200 volts from the generating station to the same distributing centre. A loss of 2 per cent. in the high pressure mains, and of 4 per cent. in transforming—total, 6 per cent.—in the former, may be fairly balanced by a loss of 15 per cent. in the latter. The additional size of the low tension plant is counterbalanced by its lower price. The low tension main, required to carry 400 kilowatts at 200 volts pressure through 1,200 yards of distance with a loss of 15 per cent., would be about 4 square inches of copper in each outer conductor, and two square inches in the middle wire. Such a line, using the largest insulated cables made, and drawing them into 10·3-inch "ways" of casing, would cost more than £15,660, representing an annual charge of £490, or 5·4 per cent. on each unit sold. Mr. Crompton will, I hope, give us the cost of the same sections of bare copper strip laid in culverts on his system, if he can keep his culvert within 160 inches sectional area.

It being very desirable that the works of distribution in the City should receive efficient criticism, Prof. S. P. Thompson was (at my suggestion) asked in October, 1891, to advise and report, which he did; and I regret that circumstances permit me only to give the sense of his reports.

He dealt with the subject of any possible advantage from the use of low tension dynamos and step-up transformers at the generating station, in comparison with the generation and transmission at 2,000 volts as specified, without recommending any change in the designs.

He recognised the extreme difficulty, in certain thoroughfares, of getting ways for the laying of conduits; in certain rich blocks, of getting a cellar for a distributing station; and the necessity for the principal routes to run north and south, not east and west, because the generating stations were on the south side.

As an example, he regarded Cheapside as practically an impassable street; as it runs east and west, "as almost useless for the purpose of a route." That shops in it must be approached through side streets and from the rear he considered in reality as no disadvantage, "for lamps are wanted most, not in mere frontages, but in back offices."

He thought that there was the less need in the central areas to trouble about keeping them of equal size, since the distances from one sub-station to another were necessarily short. Having secured a sub-station in any one spot, it was easy to estimate, from the accommodation it affords, the extent of the district which it will subserve.

He told me that the general plan I had prepared of distributing the alternating current at a pressure of 2,000 volts by mains to transformer sub-stations "could not be improved upon," and agreed entirely in principle with the general plan of distribution as provisionally set out in the maps shown this evening; and, further, approved generally the size of areas assumed in those maps to be suitable, and that the richest areas so mapped out are the eight areas surrounding the Mansion House (see fig. 18), marked respectively, C^1, C^2, C^3, C^4, and E^1, E^2, E^3, E^4.

The diagram map shows eight central districts in the City which were presumed to be those richest and having the largest immediate demand.

He agreed entirely with me in deprecating the provision of mains, through long streets, as had been laid out in the pioneer contracts, and saw the need to break up long streets into sections, each such section to be supplied as part of a compact surrounding area.

The exact delimitation, even, of the individual areas he considered a less important matter than their compactness, solidity of work, and efficiency of supply.

At that time, and with the same gentleman, the question of automatic switching of a bank of transformers was discussed. It was a novel one as regards experience. We regarded it as essential that, although at first manual regulation with daily shifts of attendants could not be avoided, eventually it would have, for economical reasons, to be done automatically. And in connection with this the inventions of Messrs. Gordon, Mordey, Tomlinson, Ferranti, and Kapp were considered. Of these well known electrical engineers some are present, and will, I hope, give us the benefit of their remarks on this very interesting and important part of the subject.

Execution of the City Street Work.

Although it may not fall to the lot of any present to have to carry out a similar work under the same conditions, it seems to me that a short account of a portion of what was done in the City streets may prove instructive to engineers.

Our papers are generally very full of technical interest, but few ever narrate the practical working engineer's experiences. This must be my apology for some diffuseness.

Enforced inaction for an engineer is always irksome, especially as he is well able to anticipate the loss and overwork that must follow through dilatoriness of those whose duty it is to make up their minds.

Such was my position between July and December, 1891, when valuable time was lost, and heavy and pressing work, requiring to be completed by the end of February, 1892, had to be suddenly put in hand.

Fortunately I had foreseen the rush that would come, and had engaged and organised my office and staff so as to be ready to go to work when required, and had also called for and received tenders for the various kinds of articles of plant and materials (several of which had to be specially designed) that the work would require.

The chief difficulties that had to be faced, besides those inseparable from street work in the City, were (1) the time of year (all the fine autumn had been lost), with its wet, mud and fogs; (2) the difficulty of readily finding a sufficient number of *suitable* foremen to take charge of such work; (3) the inconvenience caused to the public by having 100 yards of footway "up" in nearly 30 different places at one time.

My estimates of the cost of the work had been based on the assumption that it would be carried out under our own staff, by

hiring labour, and by purchasing tools and material, with a reasonable rate of progress. There was no doubt whatever that the intermediary of contractors would be wasteful, even although it was easy to find road and paving contractors in every city of the kingdom.

Time being precious, and the commissioners threatening, my ideal could only be partially carried out. Tenders had therefore to be called for for separate sections of the obligatory streets; but here the obvious difficulty of price had to be faced. No contractor would quote to lay anything under a City footway without at least 100 per cent. margin, unless he could first take up the surface. But this first taking up was not permissible. Tenders, under such conditions, were obviously objectionable.

Then, considering that we wanted several contractors to go to work at once, besides our own gangs, it would have sent the price up a hundred-fold, if their tenders were to include the supply of tubes, cases, and material, because they would have been competing for such unprecedented quantities in the same market.

There was only one course to follow, namely—

1. To purchase all the materials ourselves.
2. To prepare a specification and schedule of measured prices especially suitable and confined to the kind of work.
3. To pay for the work under measurement.

As regards the first, namely, the material:

Wrought-iron tubes, although a considerable stock is to be found amongst makers, are not held in quantities representing hundreds of miles, particularly of the quality of iron, and lap-welded, that we wanted. Our tests of samples were necessarily hasty, but the steam hammer, though rough, gave us a pretty fair indication of toughness.

The very fact of so large a quantity being wanted, instead of enhancing the price, enabled us to do what is called "break the ring," and I believe it is one of the very few cases in which tubes have been sold some 20 per cent. below "ring" prices. All the tubes were treated with Angus Smith compound.

As regards the Callender-Webber casing, there was only one maker; but here again foresight on behalf of the City lighting had a long time previously provided for special rates in favour of that particular work. At the same time, I cannot speak too highly of the great efforts of Mr. Tom Callender at that time to extend his company's means of output, and that at very short notice. I remember that at one time the bitumen we were bound to lay underground in January, 1891, was still, in Christmas week, 1890, on board ship in the chops of the Channel.

As regards the second, namely, the specification and schedule (of which a copy may, if the council permits, be attached), it is sufficient to state the former consisted of 44 clauses, and that the latter had 55 items, which the tendering contractors were asked to price.

But even with these precautions it was felt that, in the case of the most difficult streets, no contractors could be asked to tender at all except they were allowed to charge for whatever they paid out, and then with no obligation to meet all the liabilities for damage to person and property in the most crowded and intricate places in the whole world.

To our own engineers and men the work in such places as Cannon Street, Thames Street, Cheapside, Poultry, St. Paul's Churchyard, and around the Bank, &c., was allotted.

In the 22 streets in the eastern and central districts which remained to be dealt with at the end of December, the total length of trench to be excavated, and completed with conduits and boxes, was nearly 24,000 yards, of which 9,700 was allotted to the company's gangs.

There was only one month to do it in to carry out the conditions of the contracts with the Commissioners.

Three contractors at first—afterwards a fourth was added—competed successfully.* The abstracting of all the tenders showed a variation on the average work between £188, the highest, and £79, the lowest, per 100 yards of work. The highest tender accepted was at the rate of £128 per 100 yards. The same work in the more difficult ground done by the company's gangs cost only £60, including the cost of the plant used by them.

The average cost of the materials was about £118 per 100 yards.

The actual cost of the work essential to be completed in February was about £59,000. The maximum rate of progress was attained at the beginning of March, 1892, when 1·65 miles of trench was completed in six days' work.†

A glance at the map (fig. 18) will show that in the heart of the City there are eight transformer areas designed; and, naturally, as soon as the main thoroughfares were completed, to the completion of conduits in the lesser thoroughfares, streets, and courts of these areas was immediate attention turned.‡

It will be readily understood, by a glance at the plan, that the streets bounding the areas having been completed with all the "ways" actually necessary, and that could be put in, the internal cross streets could be provided with all that the future load could possibly demand for feeders of any size.

A more precise idea of the cost of this kind of work laid in streets presenting exceptional difficulty is given below.

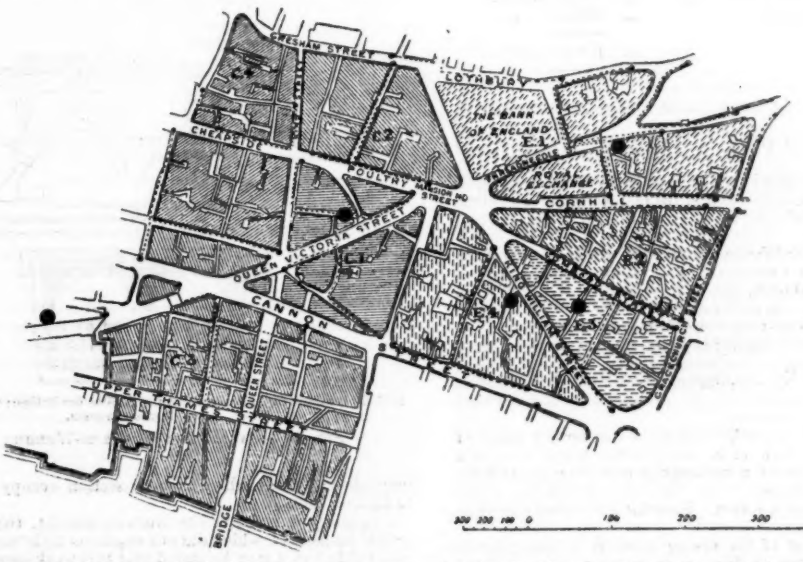
If the same work had been carried out at the rates of the highest tenders accepted, it would, including material, have cost £72,000, and if entirely in the way my estimates contemplated, the costs would have been, correspondingly, £40,000; but in neither event, having been begun in December, would it have been all done, as was essential, early in February.

* Nine firms tendered.

† An analysis shows that the 4,260 yards by one of the contractors, at £128 + £118 = £246, cost £3,069 more than it would have cost if done by the company's gangs; that the 4,010 and 5,270 yards of the two others respectively cost £2,560 and £1,265, correspondingly more; giving a total of £6,894.

But it may fairly be said that, if the contractors had tendered to do the work when the days were fine and long, their prices would have been 5 per cent. less—say £723.

It may be instructive to young engineers present to realise that, if the adverse conditions I describe could have been avoided, a saving of about £7,617 on what actually cost over £30,000 would have been effected; and that is exclusive of the advantages in the minor results in the form of better "finish" when the work is done under one's own foremen.



C_1, C_2, C_3, C_4, are four transforming areas in the Central District; E_1, E_2, E_3, E_4, are four transforming areas in the Eastern District. The dots define feeding points.

Fig. 18.—Centre of City.

‡ The amount that had to be paid for the work done in the streets by the pioneer contractors (already referred to) was £22,850, which, added to the previously stated amount, came to a total for the main thoroughfares of the eastern and central districts of £81,850. In the whole City there are 92½ miles of frontage, and in the eight special areas there are 22,000 yards. If the average demand for lamps is 2·1 per yard, we get 46,200, or about 6,000 per sub-station area; but, being the richest areas, three lamps per yard, or 8,500 per acre, was estimated. By March, 1892, the cost of the work (not done by contract) could be pretty closely detailed, and the cost of the conduits in portions came to a little over £17,000; giving a total for the completed street work in the main thoroughfares and eight sub-districts of the eastern and central districts, exclusive of conductors (except a small quantity of cable provided under the pioneer contracts, which is included), of £98,850. Of this, the length of trench completed by July, 1892, was 43,000 yards. I have little doubt we shall be told that most of the lighting in those areas is with 16 C.P. lamps. In this respect, I think it is evidently the wrong initiative policy to try

In an example of the streets in question only eight "ways" could be introduced under the footways on each side, viz.:—

	Ways.
In Callender-Webber casing	3
In 1¼-inch tubes	4
In 2½-inch „	1
Total	8

The length of the two sides, taken together, inclusive of the lengths occupied by boxes, is 1,328 yards.

The cost of taking up the surface and temporarily relaying it, at 3s. 9d. per yard lineal, was	£250
Laying conduits and pipes, at 1s. 3½d.	85
Cost of „ „ at 8s. 6d.	718
Superintendence, storekeeping, cartage, sundries ...	78
Small stores and blacksmith's work	27
Wear and tear of plant, and contingencies	116
Cost of draw-boxes and service-boxes where actually required	99
Approximate cost of restoring the surface, performed by the Commissioners' contractors, and on their schedule	554
Total	£1,927

Or £1 9s. per yard lineal of trench, exclusive of cables.

The equipment of this line with cables of the following sections, namely:—

2 of 0·3 square inch section of copper	for low
1 of 0·15 „ „ „	pressure,
4 of 7/16's	for high
1 of 0·158 square inch (concentric	pressure,

costs, in addition, £2,037; giving a total cost per yard lineal, inclusive of cables, of very nearly £3.

Including casing used for house services, the total length of ways in bitumen concrete casing laid in the streets and areas named up to July, 1892, was:—

In casing unsheathed with iron	4,356 yards.
„ sheathed in iron	148,068 „
Total	152,424 yards.

Or over 80 miles.

The internal diameter of these varied between 1 inch and 2⅜ inches.

The largest proportion of these were of the triangular form (exhibited this evening).

The total of 1¼-inch wrought-iron tubes laid was 173,000 yards, or 98 miles; of 2½-inch wrought-iron tubes, 164,000 yards, or 93 miles. Total of ways of all sorts laid in the City between December, 1891, and July, 1892, 271 miles.

Of the Raworth-Callender-Webber conduit, of which a sample is also exhibited, 212 yards, containing four ways, were laid in Queen Street. This was an experiment, and is an example of paper-lined ways bedded in bitumen and lying in cast-iron troughs, with separate cast-iron joint-pieces, and cast-iron covers bolted down.*

The durability of the paper has yet to be tested, but of this I have little doubt, if it is thoroughly impermeated; the only drawback is that the ways cannot be easily bent during laying, and that, as laid in the City, the cast-iron cover has to be cut through with a cold chisel to make a house-service connection.

The sheathing of the Callender-Webber cases was mostly made of No. 22 gauge sheet mild steel, which covered the three sides of a triangular and the four sides of a rectangular case, then secured by studs or cut-in pieces, or 1½-inch hoop iron riveted, and the whole painted over with a bitumen solution. Sheathing for these cases was first used in the City work.

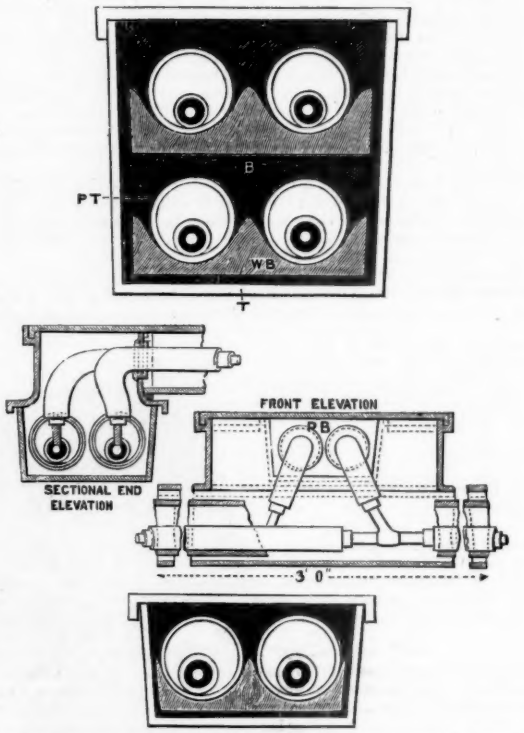
As is well known, the cost of the casing when it is triangular in section and has three ways of 1¼-inch diameter each is, without sheathing, 1s. 11d. a yard, which is 7⅝d. for each way; the same sheathed costs 2s. 10d., or 11⅛d. per yard.

Nearly all the 1¼-inch wrought-iron tubing laid (generally four tubes under each footway throughout)† cost 9½d. a yard, which was an exceptionally low price, for the reason I have already given; this is, against the first cost per yard of ways of the former material, less by 1⅞d. per yard. The advantages of the bitumen case, I think, more than counterbalance this. (1) durability; (2) there is less labour in making two bitumen joints than three screw joints (the former are 6 feet apart, the latter 12); (3) the bitumen is more easily cut to lengths and bent than the wrought iron; (4) there is no risk of rust scaling in the cables after they are in the bitumen ways, as often occurs with iron ways.

When you come to compare the 2½-inch ways in bitumen and wrought-iron, the costs are as follows:—In the former each way in a *sheathed* case costs—

	Per yard. s.	d.
With triangular section, three-way	1	9⅛
With rectangular section, „	2	1

This at once compares favourably even with the exceptional low cost of our 2½-inch wrought-iron tubing used in the City, which was 2s. 6½d. And when there are six 2½-inch ways in a case, the cost per way comes out 1s. 5d. per yard, and a large economy is at once evidenced (increased if the cost of sheathing is avoided). But it must at the same time be noted that where we laid 18 (and more) 2½-inch tubes in the same trench with other conduits—for instance, throughout Thames Street—we might not have found room for three more six-way cases, which in cross section occupy more space than 18 2½-inch tubes.



B, Solid bitumen; P T, Paper tubes; W B, Wooden bridge; T, Cast-iron trough P B, Porcelain bush.

Fig. 19.—Callender-Raworth-Webber Conduit.

I have not referred to the western district, the contract for the public lighting of which did not require completion before November 5th, 1892; but it may be stated that this work alone required 11,614 yards of trench, which, at an average cost of £1 12s. 1d. a yard, would cost £18,630, exclusive of spare tubes for other purposes.

(*To be continued.*)

On Methods of Testing the Magnetic Qualities of Iron. By Gisbert Kapp, Member. (*Paper read Thursday, February 22nd*, 1894.)

The industry generally comprised under the term "heavy electrical engineering" has of late years made such rapid progress, that the question as to the kind of materials to be used has become of great importance. As regards the copper wire required in the construction of electrical machinery, certain standards regarding the size and conductivity have from the very first been adopted. The metal of commutator plates, size of wearing surface, type and number of brushes, dimensions of resistance coils, and other purely electrical parts of the machinery, have also, as a rule, been specified; but as regards the iron used no attempt was at first made to define it by specification. Makers of dynamos, for instance, broadly distinguished between cast-iron and wrought-iron field magnets, and got out their designs with reference to the magnetic properties each of these two kinds of iron was assumed to possess; but there was no certainty that the iron obtained did actually possess these properties. If the machines turned out according to design, well and good; if not, then the speed or excitation had to be altered so as to get the output right. This was the old and unscientific method of building electrical machinery. The modern method is very different, and far more certain. The manufacturer of a dynamo knows exactly what kind

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to make up a big load before you are ready, in order to make a fair show, instead of keeping it down when first starting by encouraging in every possible way an economy of light by the use of 8 C.P. lamps, It is well known that I have been from the first an advocate of this policy, and I now attribute our measure of permanent success at Chelsea as being largely due to it.

* This latter system, called the "Callender-Raworth-Webber," in which I am joined with those gentlemen by an act of courtesy on their part, is chiefly attractive to me through the possibilities it offered for the use of bare stranded copper. Since then I have brought out, in conjunction with those gentlemen, a further development, being a combination of the two systems above-mentioned, called the "Webber-Callender-Raworth" conduit, which I hope may be a step in advance in that much-to-be desired direction. Of all the systems I am able to show examples to-night by the kindness of the Callender Company.

† Two 1¼-inch tubes are destined for the public, and two for private arc lighting series cables.

of iron he is using, and he is thus able to predetermine the performance of the machine with a degree of accuracy which formerly was impossible. This is especially of importance in large machines, as experimental runs to determine the characteristic at full load are not easily made, and are always expensive. In such cases it is preferable to cut a sample from the magnets, test it magnetically, and use the results of this test in designing the winding.

In some cases it is not even necessary to cut off samples and test them, as the manufacturers of forgings and castings for magnets offer now to supply these so as to conform to a certain magnetic standard, commonly defined by means of a curve in which the abscissæ represent magnetising force and the ordinates induction. Provided, then, the iron-maker supplies exactly the material which he has promised, the winding of the machine can be designed without any preliminary experimenting. Iron-makers are now keenly alive to the importance of this subject, and produce most excellent material. The testing of iron plates intended for use in alternators and transformers is another of those questions which had to be faced by manufacturers who wished to attain perfection in their work. As regards transformers, it will probably be admitted by all that the quality of the iron is the most important factor in the whole design. To make a good dynamo with inferior iron is still possible; we need only use enough of it, and spend enough money on the copper to make up for the deficiency in the iron. With transformers this cannot be done. If the iron is bad, no increase in its bulk, and no amount of money we may spend on copper, will enable us to turn out a good transformer. The important point with transformer plates is not the higher or lower permeability, but the waste of power by hysteresis and eddy currents; although to a certain extent the two go together, in the sense that a very soft iron having high permeability also has, as a rule, a small hysteresis loss. Plate makers, recognising the importance of small hysteresis, now offer their material with a guarantee that the loss with a given induction and frequency shall not exceed a certain amount per pound.

Admitting, then, the necessity for magnetic tests of iron, the question as to method arises. There can be no doubt that the methods adopted by Dr. Hopkinson and Prof. Ewing in their classical researches give the most accurate results; but the very perfection of these methods forms a drawback to their adoption in engineering works where highly trained experimenters cannot be found. I have therefore adopted other methods, which do not aim at absolute accuracy, but which can be used by any one of the staff generally found in the test room of electrical engineering works. The apparatus required is on the table, and I venture to bring it before you because it has been in use for some years, and has given results which were always found sufficiently accurate for all practical purposes.

It will be convenient to divide the subject into two parts—one dealing with the testing of magnet iron, and the other with the testing of transformer plates.

Testing Machine for Iron Bars.

This is shown twice full size in the wall diagram. For the principle on which it is based I am indebted to a little instrument devised some four years ago by Prof. Silvanus Thompson, and called by him a "permeameter." In it the induction through the sample bar is measured by the force required to pull the bar away from another piece of iron; and, as the induction is proportional to the square root of this force, it is clear that any small error in the measurement of this force results in a still smaller error in the determination of the induction. Thus, if his spring balance were wrong by 2 per cent., the error in estimating the induction would only be 1 per cent. So far, then, as the determination of B was concerned, the permeameter appeared to be an exceedingly accurate instrument; but this alone is not sufficient. We must have the relation of B and H, and, as part of the total ampère-turns applied is required for the magnetic circuit outside of the sample, certain corrections must be applied in the determination of H. It was mainly with the object of making these corrections both small and definite that I altered the design of the Thompson permeameter and made it in the form shown on the diagram. The instrument consists of a heavy rectangular frame, made of the best Lowmoor iron, well annealed. Within the frame is fixed a solenoid with subdivided winding, so that a variable, but known, number of turns can be placed in circuit by using the various terminals provided on the instrument. The object of this arrangement is to keep the current within such limits as will ensure the greatest accuracy in its measurement, whilst the magnetising force is varied between very wide limits. A reversing switch is inserted to facilitate the investigation of the complete cycle.

The sample consists of a bar accurately turned, and faced at the lower end. The bar is kept larger at the upper end, where it passes through a hole in the frame—a fairly tight fit—and it is centred near the lower end by a little gun-metal ferrule. Below the bar is a soft iron plunger, guided in a hole in the frame, and provided with an attachment for holding a scale-pan and weights. The plunger is made larger than the bar, and has a fine hole drilled through it to ensure good contact over the rest of the surface. The dimensions of the plunger and the hole in the frame being accurately measured, it is, of course, quite easy to determine by calculation how much of the ampère-turns provided is required to overcome the resistance of the annular air space: and this is the only important correction required. The other corrections, such as the magnetic resistance of the frame, or that of the joint between the sample and the frame at the top, are quite trifling. Even the correction for the resistance of the air space is only important for low inductions. For inductions above 10,000 it becomes relatively small, and above 15,000 quite negligible. The method of using the instrument is as follows:—The sample, with its end carefully faced, is inserted from the top, and a small current sent through the solenoid, using the smallest number of turns. The plunger flies up against the sample and sticks there. The scale-pan is attached, and weighted until the plunger comes off. The exact point at which the weight overcomes the magnetic attraction is best determined by slightly varying the current by means of a rheostat; and I may mention that it is necessary to use a storage battery to provide the current. To work directly from a dynamo is impossible, as the slight variation in current produced by the irregularity in speed of the engine, or the flickering of a belt, is quite sufficient to make the tearing-off point uncertain. The current, number of turns in the solenoid, and the weight are now increased step by step, then decreased again to zero. The current is then reversed, and the operation repeated, so as to obtain the complete cycle. The values recorded are ampère turns and tearing-off weight, in which is, of course, included the weight of the plunger and scale-pan. The greatest weight support by a half-inch sample bar of good iron is about 45 lbs. I need not detain you by giving in detail the calculations for finding the relations between ampère turns and H, or weight and B, nor the values of the corrections,* since these are purely elementary matters, and can be worked out for any testing machine of this type if its dimensions are known. The time occupied in testing a sample through a complete cycle is about an hour; one man manipulating the weights, and the other the current. The latter also books the readings.

I have used the apparatus before you in testing large numbers of samples of cast iron, wrought iron, and mild steel submitted to me for investigation by different iron makers, and some of the names obtained are on the table. For obvious reasons, I do not mention any particular maker of magnet steel; but I may say generally that the samples of steel submitted to me were very good, and in some cases better than wrought iron. The good qualities of mild steel as revealed by the testing machine were fully confirmed when the same material was used in dynamos and thus tested on a large scale.

Testing Machine for Transformer Plates.

My first attempt to make such a machine was a failure, but, as failures are sometimes as instructive as successes, I have placed the machine on the table for your inspection. In this machine I did not measure the power lost in the sample, but endeavoured to get an approximate means for comparing the permeability of different samples. An iron ribbon is coiled up to form a closed ring, and this is wound on opposite sides with coils so connected as to produce consequent poles over the two sides kept free from winding. The sample is made up of narrow strips into a flat bar, which is laid across the poles to form a magnetic bridge. The sample is surrounded by a pilot coil, and this is connected with an electrostatic voltmeter. If the same current is always sent through the main coils, and at the same frequency, then the volts produced by the pilot coil are supposed to give, roughly, an indication of the comparative value of the samples. The method was a failure, partly because permeability is not an absolutely reliable guide in estimating hysteresis loss, but chiefly because the uncertainty in estimating the magnetic resistance of the joints completely swamped any small differences that might have existed in the permeabilities of the samples. I therefore promptly abandoned this instrument, and set to work on another which would give directly that what we want to measure—namely, the losses at given inductions.

This instrument is shown on the table, and twice full size in the wall diagram. It consists essentially of a closed magnetic circuit of rectangular shape, the two longer limbs being enclosed in existing coils. One long limb and the two uprights are composed of plates in one piece: the other long limb is formed by the sample plates, which are laid together so as to make up a certain weight, and are then bound together with tape and inserted through the top coil. The sample is fixed by wooden wedges. The coils are connected with a source of alternating E.M.F. through a wattmeter, and the instrument is thus ready for use without further preparation beyond making up a bundle of plates into a sample bar and inserting the latter. The instrument is calibrated once for all by making the sample and the fixed part, or yoke, of the magnetic circuit out of the same quality of plates, measuring the loss of power at different inductions, and apportioning the losses between the yoke and sample according to their weights. When testing other samples the total loss is measured by the wattmeter, and from this is deducted that portion of the loss which is occasioned by the iron which forms part of the instrument, the remainder being the loss in the sample. A correction must be made for the loss of power resulting from the ohmic resistance of the two coils, but this is exceedingly small. The induction is found from the E.M.F. applied to the coils and the frequency. In order to have a wide range of induction, and yet keep the measurements of current and E.M.F. within the limits most convenient for the instruments at hand, the coils are sub-divided, and suitable terminals are provided. The resistance of the joints between the sample and the yoke is immaterial, as it influences only the current, but not the power.

A curve submitted showed average results obtained in testing samples of plates furnished by several different suppliers of transformer iron. I say advisedly "suppliers," and not makers, because it sometimes happens that the same brand of iron, under different

* In the instruments exhibited, the corrections for top of sample, frame, piston, and air resistance collectively amount to $\frac{2{\cdot}37}{1{,}000}$ B ampère turns, to be deducted from the total ampère turns. Thus, for B = 12,000, which would be the lowest induction of practical importance, 28·5 ampère turns would have to be deducted from a total of about 300; whilst for B = 15,000 the corrections would be 35·5 to be deducted from a total of about 1,500, and for higher inductions the correction becomes quite negligible. If B is the tearing-off weight in pounds, $B = 2{,}973\sqrt{F}$; and if X represents the corrected ampère turns, $H = \frac{X}{20{\cdot}2}$.

names, is supplied by different iron merchants. In fact, I have had a case in which two samples supplied by rival merchants gave precisely the same curve, and on making inquiries I found that the iron came indeed from the same maker, but was sold under different names. Another curve which the author showed gave the results obtained with the best sample I ever tested. As it is not my purpose, and as it would indeed be improper to advertise any particular maker in a paper of this kind, I trust you will not expect me to give his name. The curves are, for convenience in use, plotted under the supposition that the frequency is 100. The abscissæ give induction, and the ordinates loss of power in watts per pound of iron. The thickness of plates varied between 10 and 13 mils. Within these limits I believe that the thickness has only a very small influence on the loss—at any rate, I have not been able to detect any such influence; and this confirms an admirable investigation by Prof. Ewing in which he showed, on theoretical grounds, that a reduction of thickness below about 13 mils is of no advantage. It is, of course, quite easy to test transformer plates by taking a known weight of stampings and making them up in a transformer with only one coil (preferably a low-pressure coil). If the same coil be always used for this purpose, the results will be perfectly reliable. The method is, however, tedious when a number of samples has to be tested, as time is wasted in building up and taking to pieces again the plates between each set of tests. With my testing machine all the samples can be prepared before hand, and slipped in quickly one after another, so that the whole series of tests can be performed under the same conditions and by the same men. The facility with which samples can be changed is also of value if it should be necessary to verify any doubtful point in the curve obtained in a previous test.

There is another and very obvious method of testing transformer iron, and that consists in making up a complete transformer with the sample plates to be tested. Apart from the waste of labour entailed if the iron should turn out bad, this method is very uncertain. The reason for this uncertainty is that we test, not the iron alone, but the complete transformer, and we are thus left in doubt as to how much of the measured loss is really due to the iron. Theoretically the whole loss is due to the iron, but in practice this is seldom the case. When testing a transformer immediately it is completed, and again after some weeks during which it has been regularly at work, you will find that its losses have become less. This I believe to be due to the coils having become thoroughly dry, and their insulation higher. A very small electrical leak in the high-pressure winding may easily lead to a waste of power, which, although small in itself, and not capable of doing any damage, is still appreciable when compared with the true iron loss. Take, for instance, a 4-kilowatt transformer wound for 2,000 volts. Its iron loss would be about 2 per cent., or, say, 80 watts. Suppose, on testing this transformer, you find that the loss is not 80 but 100 watts. You might then conclude that the iron has 25 per cent. more loss than it ought to have, and you would condemn the sample. This might, however, be an unjust verdict. The extra 20 watts measured might very well be due to a general leakage of current across the turns of the coil. The leakage surface is large, and the pressure is large, so that the current-density of the leak is very small, and no damage will be done. The leak vanishes as the transformer gets dry, and thus may be explained the curious fact that a transformer gets better after use. The moral of this is that to do justice to a transformer the final test should only be taken after it has been at work for some time.

In conclusion, I wish to express my thanks to Messrs. Johnson and Phillips for the loan of the testing machines here exhibited.

NEW PATENTS—1894.

2,990. "Improvements in electric tramways." T. Parker. Dated February 12th.

3,013. "Improvements in apparatus for drawing through electrical or other cables or conductors in underground pipes or conduits." S. A. Mahood. Dated February 12th.

3,020. "Improvements in induction electrical machines." F. Tudsbury. Dated February 12th. (*Complete.*)

3,035. "New or improved electrically-operated instrument for tattooing the skin." S. Macdonald. Dated February 12th.

3,052. "Improved method of advertising by means of an electric lamp." J. W. Ewart. Dated February 13th.

3,056. "Improvements in and relating to electrical safety fuses." A. Marr. Dated February 13th.

3,072. "Improvement in arc lamps." J. E. Woolverton. Dated February 13th. (*Complete.*)

3,079. "An electric bell indicator." H. Sanders. Dated February 13th.

3,080. "Improved method of fixing electric call bells." W. P. Theermann, W. Crookell, and G. C. Elliott. Dated February 13th.

3,101. "Improvements in armatures for dynamo-electric machines." W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. Dated February 13th.

3,108. "Electric railways." P. W. Leffler and C. E. Corrigan. Dated February 13th. (*Complete.*)

3,109. "An electric locomotive for combined adhesion and rack traction." J. Imray. (Communicated by F. Rinecker, Germany.) Dated February 13th.

3,111. "Improvements in electric signalling devices." R. Haddan. (Communicated by A. S. Williams, United States.) Dated February 13th. (*Complete.*)

3,118. "Improvements in the regulation of electric motors." I. A. Timmis and A. I. Smith. Dated February 13th.

3,125. "Improvements in armature connections for dynamos." O. Dufault. Dated February 13th.

3,130. "Automatic cut-out or regulator." L. B. Miller and M. W. Woods. Dated February 13th.

3,155. "Combined casings and insulators for electric wires." W. Williams and T. B. Johnston. Dated February 14th.

3,166. "Improvements in underground conductors of electrical tramways." J. B. Howard. (Communicated by W. Simon, W. Beissbarth and J. Beissbarth, Germany.) Dated February 14th.

3,217. "Improvements in electric arc lamps." H. F. Joel. Dated February 14th.

3,223. "Improvements in heating of gases by electricity." W. Donaldson. Dated February 14th. (*Complete.*)

3,234. "Improvements in the locking mechanism of common road vehicles propelled by electromotive or other power." W. C. Bersey, E. J. Clubbe, and A. W. Southey. Dated February 14th.

3,245. "Improvements in lead-covered electric cables." D. Cook. Dated February 15th.

3,273. "Improvements connected with arc lamps." A. Chester and J. J. Rathbone. Dated February 15th. (*Complete.*)

3,277. "Improvements in the construction and methods of manufacture of electrical cables." G. H. Nisbett. Dated February 15th.

3,291. "Improvements in electric arc lamps." A. W. Money and H. Nash. Dated February 15th.

3,294. "Improvements in electric lighting apparatus for gas burners." M. Peterson. Dated February 15th.

3,312. "Improvements in electric arc lamps." H. H. Cooper and the Electrical Installation Company, Ltd. Dated February 15th.

3,355. "Improvements in and connected with turbines." S. Harrison and G. H. Harrison. Dated February 16th. (*Complete.*)

3,363. "Improvements in arc lamps." S. S. Allin and W. H. Wood. Dated February 16th.

3,368. "A method of and apparatus for utilising the force of waves to produce motive power." T. M. S. English. Dated February 16th.

3,376. "Improvements in appliances or means for securing the covers to the casings of electric light wires, applicable also to other purposes." J. B. Holroyde. (Communicated by C. J. Holroyde, Australia.) Dated February 16th.

3,384. "Improvements in incandescent electric lamps." J. W. Turnbull. Dated February 16th. (*Complete.*)

3,399. "Improvements in apparatus for obtaining a rotary magnetic field." W. Langdon-Davies. Dated February 16th.

3,422. "Improved method of and means for generating steam by electricity." W. Rockliffe. Dated February 17th.

3,426. "Improvements in electric lamps and in the holders or sockets therefor." D. Hunter and W. A. Jack. Dated February 17th.

3,450. "An improved flexible and electrically insulating shaft coupling." W. R. Wynne. Dated February 17th. (*Complete.*)

3,460. "Improvements in draw-tongs for telegraphic and other purposes." G. Plumpton. Dated February 17th.

3,468. "Hygienic safety device or guard for telephones." E. Pollak. Dated February 17th.

3,469. "Improvements in dynamo-electric and electro-dynamic machines." P. Poschmann and R. Hanisch. Dated February 17th.

3,476. "Improvements in and connected with electric bells." H. B. Little. Dated February 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

18,039. "Improvements in electrolytic cells and diaphragms." J. Hargreaves and T. Bird. Dated October 10th. Relates—1st, To the formation of electrolytic cells or diaphragms of wire gauze or perforated metal, upon which are deposited any suitable fibre, such as asbestos, or vegetable fibres in the form of pulp, so as to form what may be called a kind of paper or felt adhering to the said gauze or perforated metal. 2nd. To the deposition on paper or felt—for the purposes above named—of porous stone-like material such as Portland cement, plaster of Paris, or mixture of clay and silicate of soda. 3rd. To the deposition, in some cases, of the said porous, stone-like material directly upon the said gauze or perforated metal without the intervention of fibrous materials. 4 claims.

23,101B. "New or improved galvanic batteries." C. A. J. H. Schroeder and H. E. R. Schroeder. Dated December 15th. Each cell of the battery consists of a chamber divided in the centre by a porous partition into two compartments; which are each supplied by means of two tubes with different mixtures of gases. In each of these compartments are two "decipients." Local action is set up by heating the decipients, and then placing them in each compartment containing gas-mixtures. The decipients will then remain red hot by local action as long as fresh gases are supplied. No other action occurs until the decipients are brought into conductive contact with one another, when the main action of the battery takes place, consisting in the chemical combination of the gas contained in the one compartment with that in the other. 5 claims.

23,773. "Improvements in electric smelting and in furnaces therefor." R. Niewerth. Dated December 24th. The furnace consists of firebricks enclosed in metal, the top of the furnace is loose and sealed by water or other suitable joint. A pipe is connected to furnace to introduce gas and a second to withdraw it. 6 claims.